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Emoční paradox schizofrenního okruhu

THE EMOTION-PARADOX IN SCHIZOPHRENIA SPECTRUM DISORDERS

Disertační práce

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THE EMOTION-PARADOX

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THE EMOTION-PARADOX

Dedication

For professor Paul Nash.

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Abstract

The emotion-paradox in schizophrenia describes a dissociation between the grossly impaired perception of emotion and relatively preserved experience thereof. Most posit that the emotion-paradox arises from a generalized emotion perception impairment. Others counter that it represents an artefact of methodological restrictions or a separate dissociation between explicit and implicit emotion. This thesis aimed to explain the emotion-paradox in schizophrenia and resolve the competing interpretations of its root. Two studies were conducted to this end. The studies drew from the same sample, including 45 persons with schizophrenia of various symptomatology, and 45 controls with no psychiatric anamnesis or familial history of schizophrenia. The groups did not differ in age, gender, education or music education. In Study 1, the participants listened to musical stimuli and rated their perception and experience of the valence and arousal that these stimuli relayed. In Study 2, the participants completed a newly developed emotional Stroop task, in which they identified the colour of a series of neutral and negative descriptors of positive, negative, or no symptoms of schizophrenia. Findings of Study 1 indicated: a) that persons with schizophrenia recognize musical emotions as accurately as controls, b) that they demonstrate an association between the perceived and experienced component of a musical emotion as strongly as controls, and c) that they may perceive and experience musical emotions with higher intensity than controls. Study 2 suggested that persons with schizophrenia demonstrate a healthy level of interference towards negative words, but may exhibit increased reactivity towards emotional stimuli which describe their specific symptomatology. The results support the second alternative interpretation of the emotion-paradox in schizophrenia, suggesting that it describes a dissociation between the impaired explicit and the relatively preserved implicit emotion. Future research should aim to identify the point of this split. This goal might be achieved by adding more measures of musical emotion processing, or by manipulating the presentation of emotional Stroop stimuli. The findings of this thesis may have several other, more practical implications. They may help explain and improve the effects of music therapy, assuming that the observed characteristics of musical emotion in schizophrenia can transfer onto other emotional processes. The emotional Stroop task could see use in prognostic studies, given that increased reactivity to disorder-related information may relate to a worse outcome.

Keywords: Schizophrenia, emotion-paradox, implicit emotion, musical emotion, emotional Stroop task

Abstrakt

Emoční paradox u schizofrenie popisuje disociaci mezi hrubě narušeným vnímáním emocí a jejich zachovaným prožíváním. Většina zastává, že emoční paradox vzniká z generalizovaného poškození emočního vjemu. Ostatní oponují, že představuje pouhý artefakt metodických omezení, popřípadě odlišnou disociaci mezi explicitním a implicitním zpracováním emocí. Předmětem této práce bylo objasnit původ emočního paradoxu u schizofrenie. Za tímto účelem byly provedeny dvě studie. Obé vycházely ze shodného vzorku, který zahrnoval 45 osob se schizofrenií o různorodé symptomatologii a 45 osob bez vlastní či rodinné psychiatrické anamnézy. Skupiny si odpovídaly věkem, pohlavím, vzděláním a hudebním vzděláním. Ve Studii 1 si probandi poslechli řadu hudebních podnětů a zhodnotili svůj vjem a prožitek jejich libosti a budivosti. Ve Studii 2 zodpověděli emocionální Stroopův test, v němž identifikovali barvu neutrálních či záporně laděných slov, která popisovala positivní, negativní či nijaké příznaky schizofrenie. Výsledky Studie 1 naznačily: a) že osoby se schizofrenií rozpoznávají hudební emoce s obdobnou přesností jako osoby bez schizofrenie, b) že projevují asociaci mezi vnímanou a prožívanou složkou hudební emoce s obdobnou silou, a c) že vnímají a prožívají hudební emoce s vyšší intenzitou. Studie 2 ukázala, že osoby se schizofrenií vykazují normální míru interference vůči záporně laděným podnětům a zvýšenou reaktivitu vůči emocionálním podnětům, které popisují jim vlastní příznaky. Výsledky podporují druhou z alternativních interpretací emočního paradoxu u schizofrenie, tedy že popisuje disociaci mezi narušením explicitních a zachováním implicitních emocí. Do budoucna by se měl výzkum zaměřit na určení bodu, v němž k této disociaci dochází. Cíle lze dosáhnout přidáním dalších měr hudebních emocí nebo upravením způsobu prezentace podnětů u

emocionálního Stroopova testu. Výsledky práce mohou mít další, praktičtější důsledky. Mohou pomoci objasnit a navýšit účinnost muzikoterapie, tedy za předpokladu, že pozorované charakteristiky hudebních emocí mají schopnost přenosu i na jiné emoční procesy. Emocionální Stroopův test může najít využití v prognostických studiích, neboť zvýšená reaktivita vůči podnětům vztaženým k poruše může předvídat zhoršení této poruchy.

Klíčová slova: Schizofrenie, emoční paradox, implicitní emoce, hudební emoce, emocionální Stroopův test

Table of Contents

List of Tables

List of Figures

List of Images

List of Abbreviations

Psychopathology

SZ	Schizophrenia spectrum
PS	Positive-symptom
NS	Negative-symptom

Behavioural methods

EST	Emotional Stroop task
SI	Stroop index
D-SI	D-transformed Stroop index

Psychometrics

ANEW	Affective Norms for English Words (Bradley & Lang, 1999)
CAPE	Community Assessment of Psychic Experiences (Stefanis et al., 2002)
CAPE-42	Total CAPE score
CAPE-dep	CAPE depression scale
CAPE-neg	CAPE negative symptom scale
CAPE-pos	CAPE positive symptom scale
MUSE	Music Use questionnaire (Chin & Rickard, 2012)
MES-I	Music Engagement Style I scale
PANNS	Positive and Negative Syndrome Scale (Kay, Fiszbein, & Opler, 1987)

Psychophysiology

EEG	Electroencephalogram
ERP	Event-related potential
EDA	Electrodermal activity
HRV	Heart rate variability
HF-HRV	High frequency component of HRV

List of Publications

Publications

Kerkova, B. & Martinkova, Z. (in press). Validizace české verze dotazníku Community Assessment of Psychic Experiences (CAPE). *Československá psychologie.*

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1. Chapter 1: Introduction

Schizophrenia is a severe psychiatric disorder which affects up to a percent of the world's population. The disorder is characterised by positive symptoms such as hallucinations or delusions, and by negative symptoms which include social and cognitive deficits. A lingering debate concerns the contribution of emotional disturbances to schizophrenia and its symptoms.

For over a century, the one accepted abnormality of schizophrenic affect has lied in its flattening, i.e. the diminishing of its strength and frequency. This limited view was in part a consequence of the Kraepelinian dichotomy (1896), in which dementia praecox, as schizophrenia was shortly known, stood in sharp opposition to affective psychoses, an early umbrella term for bipolar disorder. Although research has advised of a more potent role of emotion then already (Bleuler, 1911), it was Kraepelin whose nosological work was eventually adopted by diagnostic manuals. Indeed, current ICD (World Health Organization, 1992) as well as DSM (American Psychiatric Association, 2013) specify schizophrenia as neurocognitive and require that it be distinct from affective diseases.

However, post-Kraepelinian research is surging and pointing out some of the inadequacies of the beliefs above. Contemporary academic discourse already agrees that schizophrenia is unlikely to represent the binary opposite of an affective disorder, and adds that affective disturbances may, in fact, stand at the core of schizophrenia, thus help trigger and maintain it (Aleman & Kahn, 2005; Myin-Germeys & van Os, 2007). While flat affect can characterise the appearance of some schizophrenic states, wherein facial expressions, speech and gestures diminish, it might not mirror a similar affliction of internal processes (Trémeau, 2006). The perception and experience of emotion appear to be more intricately affected.

Meta-analyses of laboratory studies highlight that schizophrenia affects the perception and experience of emotions incongruently. Nearly one hundred studies have utilized facial expressions or recordings of prosodic speech in order to examine emotion perception (Aleman & Kahn, 2005; Phillips & Seidman, 2008; Trémeau, 2006): results agree that the identification of emotional valences is grossly impaired by schizophrenia and by the social and cognitive deficits that accompany it. Conversely, the experience of emotion has been probed via a multitude of diverse methods and materials (Aleman & Kahn, 2005; Trémeau, 2006) and appears to be generally unaffected by schizophrenia. Only in response to psychotic symptoms or their connotations do some experiences reach intense arousal or degrade in valence (Aleman & Kahn, 2005; Cohen & Minor, 2008). These abnormalities may foster a worse prognosis (Krabbendam & Van Os, 2005).

This dissociation between emotions perceived and felt has become a well-replicated finding in schizophrenia research. Yet the root of the so-called emotion-paradox is not well understood (Aleman & Kahn, 2005). Most posit that the emotion-paradox results from a generalized emotion perception impairment (see e.g. Edwards, Jackson, & Pattison, 2002; Schneider et al., 2006; Shayegan & Stahl, 2005) but critics argue that it represents an artefact of methodological limitations (Darke et al., 2013; Rossell & Boundy, 2005) or a misinterpretation of the results (Mano & Brown, 2012; van 't Wout et al., 2007).

The first alternative explanation of the emotion-paradox proposes that the dissociation it describes is untrue, and stems from methodological restrictions in emotion perception studies. Compared to emotion experience studies, which utilize a multitude of materials including videos, activities, or smells to induce or otherwise study emotion in laboratory conditions, emotion perception tasks rely nearly exclusively on facial and prosodic expressions. In a typical task, participants observe a series of pictures of faces or listen to recordings of speech, each expressing one of Ekman's basic emotions (happiness, sadness, anger, and fear, sometimes also disgust, surprise, or jealousy) (Ekman, 1999). They are then forced to identify the emotion from multiple options given or to discriminate it from stimuli expressing others. These types of tasks are a staple of emotion research but may be insufficient and confounding in the context of schizophrenia. Schizophrenia is associated with deficits in social cognition and functioning, and a variety of other cognitive disturbances. The fact that persons with schizophrenia err when perceiving facial and prosodic expressions could thus reflect deficits in processes which are not primarily emotional, including the processing of complex, semantic and socially relevant stimuli, as well as in attention and cognitive appraisal (Darke et al., 2013; Rossell & Boundy, 2005).

The second, extended explanation of the emotion-paradox suggests that it reflects a genuine, albeit divergent dissociation. Emotion perception tasks, as described above, require that participants be fully aware of the emotion that they are perceiving, and able to appraise and name it. In contrast, emotion experience studies utilize a wealth of measurement methods, including psychophysiological readings, imaging and electroencephalography (EEG), the experience sampling method or less restricted forms of self-report (such as a semi-structured interview or the circumplex model of emotion). Therefore, conclusions of emotion perception studies tend to be limited to the perception of explicit emotion, whilst emotion experience studies more commonly measure the implicit emotion experience (Mano & Brown, 2012; van ’t Wout et al., 2007). The second interpretation suggests that the emotion-paradox in schizophrenia describes a split between explicit emotion, which is diminished and flattened, and implicit emotion, which is preserved or heightened (Mano & Brown, 2012). Conveniently, this framework can accommodate the increased intensity of emotion recorded in some states of schizophrenia, or in patients responding to some types of stimuli (Aleman & Kahn, 2005; Cohen & Minor, 2008).

The primary aim of this thesis was to explain the emotion-paradox in schizophrenia, and two studies were conducted to this end. Study 1 assessed the concurrent perception and experience of emotion in stimuli of few socio-cognitive demands: music. Study 2 probed patient reactivity to implicit emotions of varying valence and symptom-relatedness, using a newly developed emotional Stroop task.

2. Chapter 2: Background & Literature Review

This thesis builds upon two critical assumptions about schizophrenia: that it is part of a spectrum, and that this spectrum includes abnormalities of affect. These assumptions require brief clarification.

First, it is assumed that schizophrenia is a spectral disease, or the pronounced expression of a trait that occurs in a more substantial proportion of the population. As such, the higher end of the schizophrenia spectrum would consist of schizophrenia and other diagnostic categories, with the lower end of the spectrum including first-order relatives of persons with a diagnosed disorder, others classified as high-risk, and – according to some (Krabbendam, Myin-Germeys, & Van Os, 2004; Stefanis et al., 2002) - parts of the general population. If belonging to a spectrum, these diagnostic and subclinical categories would share a set of qualities, including symptoms, risk factors, and processing abnormalities.

Indeed, research on such schizophrenic features supports their distribution and expression outside of the main disorder. For example, schizophrenia appears to share common aetiology with schizotypy and some forms of psychosis proneness (Johns & Van Os, 2001): similar clusters of positive and negative symptoms can characterise these (Stefanis et al., 2002). Less frequent or attenuated symptoms of psychosis have also been documented in the general population and associated with the same risk factors that schizophrenia has come to be known for, such as young age, low quality of life, and urbanicity (Johns & Van Os, 2001; Krabbendam et al., 2004; Stefanis et al., 2002). A range of schizophrenic dysfunctions in perception, attention, memory, and other cognitive processes can also be observed subclinically, with lesser effect sizes as a matter of course (Aleman & Kahn, 2005).

Note for clarity sake that throughout this paper, discussion of "schizophrenia" is typically not restricted to the diagnostic category of schizophrenia, and instead extends to the clinical end of the schizophrenia spectrum. Unless otherwise specified, this end of the spectrum includes the diagnostic categories of schizophrenia, schizoaffective disorder, and acute psychotic disorder with symptoms of or similarities to schizophrenia.

Second, this thesis assumes that schizophrenia includes abnormalities of affect, and that it may share some of these with affective disorders. This assumption may be incongruent with current diagnostic manuals (American Psychiatric Association, 2013; World Health Organization, 1992), which describe few emotional deficits in schizophrenia, and suggest a divide between the diagnostic category and affective disorders.

Academic discourse argues for extensive affective symptomatology in schizophrenia and even places emotional disturbances at the core of the primary disorder (Aleman & Kahn, 2005; Bleuler, 1911). For example, increased (as opposed to flattened) emotional reactivity may help trigger and maintain the disorder (Myin-Germeys & van Os, 2007). Academia also rejects the dichotomy between neurocognitive and affective disorders. After all, affective disorders have up to an 80% lifetime prevalence rate in schizophrenia (Livingstone, Harper, & Gillanders, 2009), and psychotic episodes maintain a distinctly emotional content (Freeman & Garety, 2003). This thesis sides with the research, considering affect and its dysfunction an integral part of schizophrenia.

2.1. Perception and Experience of Musical Emotions in Schizophrenia

The overall aim of Study 1 was to assess the view that the perception and experience of emotions in schizophrenia are not truly dissociated. Specifically, this view suggests that the perception of less socio-cognitively demanding stimuli would show a lesser degree of or an otherwise different kind of impairment, thus rendering it more closely related to the experience (Darke et al., 2013; Rossell & Boundy, 2005). To investigate this claim, Study 1 opted for musical material. This choice was motivated by the following four points.

First, the perception and experience of musical emotions can be expertly separated. The nature of musical percepts and the existence of musical experiences have long been a subject of debate in the field of music psychology, and theoretical and empirical methods to study each in isolation were devised as a result (Gabrielsson, 2002; Schubert, 2013). A perceived musical emotion is defined as the perceptual-cognitive judgment of an emotion "in" the music, and an experienced musical emotion is the emotional reaction elicited "by" the music. Percepts and experiences are two theoretically isolated phenomena which typically co-occur in reality (Gabrielsson, 2002). Accordingly, they are most often positively correlated, with experiences remaining less intense than percepts due to emotional regulation (Schubert, 2013). A dissociated musical experience occurs in varied situations. It may circumvent cognitive interference and bloom into exceptional intensity, even giving the listener 'chills' (Chanda & Levitin, 2013). Its valence could also vary, as when a sad piece of music sounds too beautiful to displease its listener (Sachs, Damasio, & Habibi, 2015). A simultaneous assessment of the emotions expressed and induced by the same stimulus is one of the more sensitive behavioural measures of their differences (Schubert, 2013) and should benefit research on the emotion-paradox of schizophrenia.

Second, musical emotions are sufficiently consistent to be studied empirically. Contrary to intuition, musical emotions are homogenous within and between individuals, rather than subjective to each one (Vieillard, Peretz, Khalfa, Gagnon, & Bouchard, 2008). Percepts and experiences also display consistency between cultures (Fritz et al., 2009) and ages (Trehub, 2003). Both discrete and dimensional models of emotions can be applied to their study. Music can express most basic emotions - though sometimes with lesser accuracy than facial or prosodic emotions (Feingold et al., 2016; Weisgerber et al., 2015) – as well as other, at times music-specific discrete emotions (Zentner, Grandjean, & Scherer, 2008). A dimensional model, describing emotions in terms of valence and arousal, facilitates the study of more nuanced musical emotions, whilst freeing the listener of the demands of their precise naming (Eerola & Vuoskoski, 2011).

Third, musical emotions require little cognitive and social ability. Children no more than two months old prefer consonance over dissonance, soon learn to identify happiness, and are able to interpret affective cues of tempo and mode by age six (Vieillard et al., 2008). Musical emotions can also flourish despite pathologically reduced social or intellectual prowess. This has been the case for autism spectrum disorder, which impairs the recognition of facial and spoken emotions. Evidence suggests that autism does not impede musical emotions, meaning that it could involve social rather than affective deficits (Quintin, Bhatara, Poissant, Fombonne, & Levitin, 2011). Similarly, music could help measure the extent to which the emotion-paradox of schizophrenia represents a generalized emotional impairment.

Fourth, variations of musical emotions in schizophrenia could have implications for treatment. Music therapy is a broadly and successfully used supplement to schizophrenia treatment (Silverman, 2003) but its mechanisms of action are not well understood. Notably, music therapy interventions draw on the assumption of a positive correlation between the perception and experience of an emotion (Gabrielsson, 2002), which the emotion-paradox of schizophrenia might violate. An empirical investigation of musical emotions in schizophrenia may also help health professionals to support healthy, everyday listening habits. Indeed, maladaptive uses of music have been observed in patient listeners (Weisgerber et al., 2015) and may have unnecessary emotional costs (Farhall, Greenwood, & Jackson, 2007).

The use of music in research on emotion in schizophrenia presents few, nonetheless important limitations. These concern potential idiosyncrasies in the neurophysiological processing of general and musical emotions in schizophrenia, and must be considered by any behavioural study as well.

Schizophrenia is associated with deficits in many auditory processes, which precipitate and/or modulate a musical emotion, and which can help distinguish a percept from an experience. Amusia, a disorder which occurs congenitally in approximately 4% of the general population, reaches a 45 - 62% prevalence rate in schizophrenia (Hatada et al., 2014; Kantrowitz et al., 2014). Perception of pitch and melody is significantly impaired and perception of rhythm and meter may also suffer (Kantrowitz et al., 2014). Event-related potential (ERP) studies add that persons with schizophrenia do not efficiently register and organize pitches – and possibly also temporal units – by their saliency, suggesting that their bottom-up processing of sound may be overburdened and not sufficiently regulated by top-down processing (O'Donnell, Salisbury, Niznikiewicz, Brenner, & Vohs, 2012). However, pitch-based auditory deficits correlate more strongly with impaired emotion recognition in speech (Leitman et al., 2010; Lu, Ho, Liu, Wu, & Thompson, 2015) than music (Gosselin, Paquette, & Peretz, 2015). Whilst pitch critically supports music perception, it is supplemented by other affective cues, which could help a sensitive subject register and construe a sharp emotion percept or experience (Leitman et al., 2010).

Schizophrenia can also disturb the autonomic system, thus some of the indices which reflect and shape the experience of arousal and valence. Experienced arousal is indexed by electrodermal activity (EDA) (Khalfa, Peretz, Blondin, & Manon, 2002). Cardiovascular activity and especially the high-frequency component of heart rate variability (HF-HRV) may represent emotional regulation (Appelhans & Luecken, 2006), or experienced musical valence (Orini et al., 2010; van der Zwaag, Westerink, & van den Broek, 2011). In schizophrenia, EDA can range from non-responsivity in remission to hyper-responsivity during psychosis (Green, Nuechterlein, & Satz, 2013), while HF-HRV is dangerously diminished by the illness and the medication used to treat it (Mujica-Parodi, Yeragani, & Malaspina, 2005). These impairments could modulate the emergence of an emotional experience and help distinguish it from perception. However, their variability between patients complicates their utilisation as indices of mental state change.

Schizophrenia may also affect the cortical treatment of emotion. This is measurable via spectral EEG, and alpha power asymmetry has been one of its more studied aspects. Alpha power reveals the inhibition of a cortical region and typically subsides over the left frontal lobe during the processing of pleasant stimuli (Davidson, 1992). Accordingly, unpronounced alpha power over the right hemisphere distinguishes musical fear or sadness (Flores-Gutiérrez et al., 2007; Schmidt & Trainor, 2001). Schizophrenia has been associated with a diffuse hyperactivity of frontocortical regions at baseline (Merrin & Floyd, 1996). When more positive symptoms are present, resting alpha may skew towards the left hemisphere (Merrin & Floyd, 1996). The findings suggest a blurring of emotional valences in schizophrenia, and a bias towards a more negative experience in some of its states.

Finally, positive symptoms of schizophrenia can be attributed to the excess and overactivation of dopamine receptors in the mesolimbic pathway (Davis, Kahn, Ko, & Davidson, 1991; Howes & Kapur, 2009). This pathway is integral to the musical experience and can distinguish it from the musical percept on a neurological level (Vieillard et al., 2008). Dopaminergic projections can activate during intense emotional responses to music (Chanda & Levitin, 2013), suggesting a release of the neurotransmitter dopamine, which plays a vital role in reward, arousal, and salience. Music-induced subcortical activation may intensify or otherwise alter the musical experience of an individual with schizophrenia.

The use of music in empirical research on emotion in schizophrenia has its benefits and costs, with the former outweighing the latter when appropriate methodology accompanies the material. Self-report may be particularly suited for an investigation of the emotion-paradox in schizophrenia, especially when coupled with the dimensional model of emotion, the simultaneous measurement of perception and experience, and standardized musical stimuli.

2.1.1. Review of Musical Emotions in Schizophrenia

Fifteen peer-reviewed studies which quantitatively examined the perception or experience of musical emotion in psychotic disorders were recovered for review. Six studies which pertained to the recognition, discrimination, or identification of emotion expressed by the stimulus were classified as emotion perception studies; nine studies which questioned emotional changes in a listener exposed to the stimulus were categorised as emotion experience studies. No studies measured both the perception and the experience of a musical emotion. Studies grossly differed in sample characteristics, stimuli selection, emotion models, and outcome measures (Table 1). Schizophrenia spectrum (SZ) groups included persons diagnosed with schizophrenia, schizoaffective disorder or a corresponding psychotic disorder as defined by earlier diagnostic criteria. Control groups typically matched SZ groups in age, gender, or education; four studies did not report a match. Notably, a single study matched participants by their musical backgrounds (Abe, Arai, & Itokawa, 2016). Participants who reported having abnormal hearing were excluded from nine studies. Musical stimuli were experimenter-selected but only six research teams provided an empirically supported rationale for their choices. Stimuli ranged from computer-generated sounds, through single-instrument recordings, to excerpts of classical music. Studies employed variants of discrete or dimensional models of emotions. Outcome measures included self-report in eight studies, other quantitative measures in five studies, and both in two studies.

2.1.1.1. Perception of musical emotions in schizophrenia

In a pivotal study, Simon, Holzberg, Alessi, and Garrity (1951) asked patients with schizophrenia, manic psychosis, and depressive psychosis to listen to short recordings of spinet, a type of harpsichord, and classify them by the sadness or happiness that they may express. While all groups were reported to succeed in discriminating between musical valences, controls made significantly fewer errors. The effect was sensitive to negative valence - patients with schizophrenia and manic psychosis misidentified sad recordings more commonly; individuals with depressive psychosis were as proficient in recognizing sadness as controls were. Authors argued that impaired ego functioning and dissociative processes were to blame for the rejection of negative affects.

Four research teams made observations which were incongruent with Simon's conclusion (1951) but also had some shortcomings. Raith, Steinberg, and Roth (1995) asked patients diagnosed with a schizophrenic disease to assess their perceptions of a wide range of emotions expressed by nine classical music excerpts. Patients were more likely to rate music as negative but a test of the statistical significance of this finding was not performed. Rossell and Boundy (2005) compared patients with and without auditory hallucinations with respect to their emotion recognition capacities. Hallucination sufferers mislabelled stimuli as more negative, and readily mistook happiness for fear. However, this study used vocalizations in place of complex musical stimuli. Abe, Arai, and Itokawa (2016) reported that individuals with schizophrenia could not discriminate between the valence of a major and a minor chord progression and that the more impaired their general functioning was, the likelier they were to associate a minor chord progression with neither sadness nor happiness. However, only a single pair of stimuli was used in this one-minute task. Lastly, Dyck, Loughead, Gur, Schneider, and Mathiak (2014) tested participants' recognition of the emotions expressed by classical music excerpts that were to be used in a mood induction study. Schizophrenia patients recognized musical happiness and sadness but exact accuracy data were not provided. These studies cast doubts on the deduction that negative valence specifically complicates schizophrenic emotion recognition (Simon et al., 1951) but cannot provide an alternative explanation.

Weisgerber and colleagues (2015) offered some elucidation on the matter. In this comprehensive study, medicated patients listened to excerpts of piano music expressing either: happiness, sadness, threat, or peacefulness. Ratings of the discrete emotions were analysed with respect to their accuracy and further compared to the same participants' performance on similar tests using vocal affect bursts and facial expressions.

Though controls achieved accuracy scores that were far from perfect, patients scored significantly worse across all disciplines. Upon closer inspection, however, their performance deficits differed between the musical and nonmusical tasks. While recognition of prosodic and facial emotions weakened as their valence decreased, recognition of musical emotions depended on their arousal, so that sadness and peacefulness were commonly misidentified for threat and happiness, respectively. Patients also assessed musical emotions as distinctly more intense. The trend grew stronger in individuals suffering from more pronounced positive symptoms, but not significantly so.

A recent study (Feingold et al., 2016) examined the roles which stimulus complexity and modality play in schizophrenic emotion perception. Stabilized outpatients were presented with visual, semantic and auditory stimuli of low or high complexity levels. Auditory stimuli included low-complexity sine waves and high-complexity violin segments. Patients performed with uniformly lower accuracy than controls - no complexity-specific deficit was observed. Authors suggested that schizophrenically-impaired emotion recognition may be attributed to deficits in bottom-up processes, including attention, but cautioned that a contribution of deficits in higher-order cognitive processes could not be excluded. A modality specific deficit was not observed either. It was beyond the scope of the study to examine the effect of arousal or valence, which would have provided a more complete picture of the findings. No significant association emerged between schizophrenia symptoms and recognition rates.

2.1.1.2. Experience of musical emotions in schizophrenia

An early study (Weidenfeller & Zimny, 1962) probed music-related changes in galvanic skin resistance of schizophrenia patients listening to classical music. Pieces of exciting music were reported to decrease electrical resistance throughout their duration, meaning that autonomic arousal was continually heightening. Calming music was associated with a delayed increase in resistance which plateaued out shortly. The study lacked a direct comparison group but argued that healthy autonomic arousal would increase further when responding to exciting music, and decrease comparably to patient samples when responding to calming music.

Two later studies recorded EDA (Akdemir, Kara, & Bilgiç, 2010) and HRV (Akar, Kara, Latifoğlu, & Bilgiç, 2015) while participants rested or listened to white noise or Turkish classical music. The music was selected for its calming and pleasing properties, though these were not affirmed experimentally.

Music appeared to foster an increase in EDA in patients and a greater increase in controls (Akdemir et al., 2010). HF-HRV did not significantly deviate from baseline in either group (Akar et al., 2015). Assuming that EDA reflects emotional arousal and HF-HRV speaks for valence, it would appear that: a) the calming and pleasing properties of the music did not translate into respective changes in autonomic indices in either group, and b) patients experienced less arousal in response to the particular piece of music. Possibly, the stimulus was more exciting than assumed and fostered the pattern of sympathetic changes theorized by Weidenfeller and Zimny (1962).

The comparative effects of music and noise are of special interest. Representing a neutral stimulus, white noise should promote a moderate level of arousal and lack a clear valence; though in comparison to other colours of noise, the dissonance and high frequency of white noise may irritate some. Indeed, white noise was associated with a significant increase in EDA in both groups (Akdemir et al., 2010). A decrease in parasympathetic activity, as indexed by HF-HRV, occurred in controls only (Akar et al., 2015). Overall, the patient group reacted very similarly to static and music. If not an artefact, this might indicate reduced responsiveness to valence cues.

Spectral EEG studies corroborate this. Burge and Siebert (2010) probed frontal alpha asymmetry values in schizophrenia inpatients listening to Bach compositions and to their computer-generated variants. The stimuli underwent increasing amounts of manipulation designed to attenuate their resemblance to the original. Assuming that unpronounced alpha power over the right hemisphere corresponds to a negatively-valenced experience, controls in this study experienced a strong distaste for the most degraded stimuli. Patients, on the other hand, demonstrated more diffuse activation, such that the steadily low alpha did not differ between hemispheres with any stimulation.

Similar findings were reported in a series of studies by Günther and colleagues (1991, 1993) who recorded overall neural activity from unmedicated schizophrenia patients suffering from serious general functioning decline. Alpha and delta frequency bands yielded signs of diffuse hyperactivation that remained non-responsive when exposed to rhythmic relaxation music, by contrast to controls and other psychiatric patients. As authors suggested, an experience of intense arousal and disorganised valence may explain the data.

Dyck and colleagues (2014) raised support for this conclusion. Controls and inpatients diagnosed with paranoid schizophrenia underwent a visual or an audiovisual mood induction procedure and their experiences were probed via self-report and functional magnetic resonance. Both procedures raised similar valence ratings between groups. Arousal was significantly heightened during the audiovisual procedure in both groups but the difference was especially pronounced amongst patients. Overall, the addition of classical music to a visual paradigm did not affect patient experiences of valence but increased their arousal.

Patient brain responses revealed great differences. Sensory areas manifested hypoactivation while higher cortical areas hyperactivated, especially during the audiovisual procedure. Increased connectivity between primary and secondary sensory areas was also observed. These findings were attributed to impaired sensory filtering in schizophrenia patients and a higher effort exerted by them to compensate for this (Dyck et al., 2014).

Burge and Siebert (2010) found that, irrespective of symptomatology, outpatients reported a greater attraction towards digitally-manipulated Bach compositions than controls, despite having an otherwise ‘correct’ experience of their valence and arousal. An earlier series of studies with over a hundred psychiatric patients observed a similar effect (Nielzén & Cesarec, 1982; Nielzén, Olsson, & Ohman, 1993): patients undergoing psychosis were more attracted to music and the difference was especially pronounced when negatively-valenced stimuli were at play. In one study (Nielzén & Cesarec, 1982), patients were drawn to short pieces of orchestral music which controls found the least appealing. In the other (Nielzén et al., 1993), patients reported an increased preference for complex synthetized sounds described as harsh and dissonant. Simultaneously, patients rated their experiences as more tense and less calming in both studies. The authors postulated that the combination of complexity and dissonance, which characterised some of their stimuli, was representative of the perceptual alterations that may occur during psychosis, and that it may have been this memory of the state that sensitized the listeners.

Table 1. Characteristics of laboratory studies on the schizophrenic perception and experience of musical emotions.

	Sample Characteristics			Musical Stimuli		Measures		
Study	Controls (*N*)	SZ (*N*)	State	Stimuli (*N*): selection	Emotion model: range	Self-report	Quantitative	Target domain
Abe et al., 2016	Matched age, gender, music (29)	Schizophrenia (29)	Medicated, stable	4s major/minor piano chord progressions (2): artificial	Discrete; happiness, sadness	Forced-choice		Perception
Akar et al.,2015	Matched age, gender (20)	Schizophrenia (19)	Unmedicated	2min white noise, Turkish classical (2):	Dimensional; relaxation		HRV	Experience
Akdemir et al., 2010	Matched age (23)	Schizophrenia spectrum (23)		2min white noise, Turkish classical (2):	Dimensional; relaxation		EDA, temperature	Experience
Burge & Siebert, 2010	Matched age (11)	Schizophrenia (8), schizoaffective (4)	Medicated, outpatients	30s computer-generated variations of Bach (5): artificial	Dimensional; valence/arousal, discrete displayed	Continuous recording, SAM-state	EEG, frontal alpha	Experience
Dyck et al., 2014	Matched age, gender, edu (16)	Paranoid schizophrenia (16)	Medicated, inpatients, stable	44s classical music (6), pink noise: pre-rated	Discrete: happiness, sadness	SAM-state	fMRI	Experience
Feingold et al., 2016	Matched age, gender (43)	Schizophrenia (43)	Outpatients, stable	5s sine waves (9), 30-60s violin (12): adapted	Discrete: anger, fear, happiness, sadness	Forced-choice		Perception

	Sample Characteristics			Musical Stimuli		Measures		
Study	Controls (*N*)	SZ (*N*)	State	Stimuli (*N*): selection	Emotion model: range	Self-report	Quantitative	Target domain
Günther et al., 1991	Matched age (39)	Schizophrenia (48), others (92)	Some medicated	30s rumba (3): artificial	Dimensional: arousal/activation		EEG, alpha and delta	Experience
Günther et al., 1993	Similar age, gender (29)	Paranoid (15), other schizophrenia (11)	Unmedicated, cognitive decline	6s rumba (2): artificial	Dimensional: arousal/ activation		EEG, frontal alpha	Experience
Nielzén & Cesarec, 1982	(100)	Schizophrenic (22), depressive (12), manic (10) psychosis, others (63)	Inpatients	Short excerpts of orchestral music (7): pre-rated complexity	Dimensional: tension-relaxation, gaiety-gloom, attraction-repulsion	12 7-step scales		Experience
Nielzén et al., 1993	(34)	Schizophrenic (11), manic (11) psychosis	Some medicated, inpatients	3s synth (7): pre-rated complexity	Dimensional: tension-relaxation, gaiety-gloom, attraction-repulsion	12 7-step scales		Experience
Raith et al., 1995	(39)	Schizophrenia (41), others (55)	Inpatients	60-90s excerpts of classical, popular music (9): artificial	Discrete: 21 emotion pairs	21 polarity items		Perception

	Sample Characteristics			Musical Stimuli		Measures		
Study	Controls (*N*)	SZ (*N*)	State	Stimuli (*N*): selection	Emotion model: range	Self-report	Quantitative	Target domain
Rossell & Boundy, 2005		Schizophrenia spectrum with (20), without (20) hallucinations	Most medicated, in/outpatients	2s non-linguistic sounds: pre-rated	Discrete: anger, fear, happiness, sadness	Forced choice, overall intensity		Perception
Simon et al., 1951	(51)	Schizophrenia (53), manic (31), depressive (25) psychosis		20s spinet (8):	Discrete: happiness, sadness	Multiple choice emotion		Perception
Weidenfeller & Zimny, 1962		Schizophrenia spectrum (18)	Inpatients	6min Dvořák, Bach: pre-rated	Dimensional: arousal		EDA	Experience
Weisgerber et al., 2015	Matched age, gender, edu (30)	Paranoid schizophrenia (30)	Medicated, stable	12.4s computer-generated piano (14*4): pre-rated	Discrete: happiness, sadness, threat, peacefulness	Intensity per emotion 0-9 Likert scale		Perception

Note. Blank spaces occur in place of missing data or unused variables.

Table 2. Schizophrenic variations in the perception of musical emotions and their correlations with stimulus valence (V), stimulus arousal (A), and symptomatology (S).

	Recognition	Perceived emotion		Other	
Study	Error-rate	Arousal indices	Valence indices	Intensity	Preference
Abe et al., 2016	↑ S		↔		
Dyck et al., 2014	~=				
Feingold et al., 2016	↑ =S				
Raith et al., 1995			↓	↑	↑ -V ~+S
Rossel & Boundy, 2005	↑ +V +S			=S	
	↑ +V =S				
Simon et al., 1951	↑↑ -V +S		↑ -V +S		↑ -V
Weisgerber et al., 2015	↑ -A ~+S	↑ -A ~+S	=	↑	

Note. Symbols denote the following: ↓ decrease; ↑ increase; = no change; ~ this effect only approached sig. or was not statistically assessed.

Table 3. Schizophrenic variations in the experience of musical emotions and their correlations with stimulus valence (V), stimulus arousal (A), and symptomatology (S).

	Experienced emotion		Other
Study	Arousal indices	Valence indices	Preference
Akar et al., 2015		~↔	
Akdemir et al., 2010	↓ ~-A ~= =A		
Burge & Siebert, 2010	↑ / =	= / ↔	↑ -V =S
Dyck et al., 2014	↑	= / ~↓	
Günther et al., 1991	↑	= / ↔	
Günther et al., 1993	↑	= / ↔	
Nielzén & Cesarec, 1982	↑		↑ -V
Nielzén et al., 1993	↑		↑ -V
Weidenfeller & Zimny, 1962	~↓ +A ~= -A		

Note. Symbols denote the following: ↔ variability; ↓ decrease; ↑ increase; = no change; ~ this effect only approached sig. or was not statistically assessed.

2.1.2. Summary & Aims

The emotion-paradox in schizophrenia denotes a commonly observed divide between the grossly impaired perception of emotions and relatively preserved experience thereof (Aleman & Kahn, 2005). Past research on musical emotions in schizophrenia made observations which match but cannot confirm the view that this phenomenon represents an artefact of laboratory material selection. Indeed, music and its relatively lesser socio-cognitive demands bred similar percepts (Table 2) and experiences (Table 3) in persons with schizophrenia. Neither component of musical emotion was convincingly preserved, and both shared characteristics which past research reserved for positive-symptom-related experiences (Aleman & Kahn, 2005; Cohen & Minor, 2008): a tendency toward ambiguous valence and heightened arousal and intensity. Neither characteristic appeared to depend on symptomatology. These results indicate that both the perception and experience of musical emotions are altered by similar underlying mechanisms, which could be inherent to schizophrenia or specific to music.

However, the collected studies differed widely in their methods, including critical aspects such as the type and selection of stimuli, or the method of measurement. Most studies left room for methodological improvement. For example, no studies used a standardized battery of musical stimuli, and only one study investigated the musical background of its participants (Abe et al., 2016). Measurement largely relied on the discrete model of emotion, which may be less suited for research on emotion in schizophrenia. Crucially, no studies took advantage of the opportunity to examine the emotion music expresses and elicits at once. This method can be more sensitive to variations between percepts and experiences (Schubert, 2013) and shall be of essence to Study 1.

The review of musical emotions in schizophrenia introduced further research questions, pertaining to: recognition accuracy; variations in musical valence, arousal, and intensity; and the role of symptomatology and symptom-relatedness.

Most studies agreed that individuals with schizophrenia recognized emotions less accurately than individuals without schizophrenia, but used inconsistent methods of accuracy measurement, and reported a varied extent to this impairment, ranging from non-significant tendencies to pronounced deficits. An effect of stimulus type (musical vs nonmusical) on accurate emotion recognition was not confirmed by the two studies which were able to analyse it directly (Feingold et al., 2016; Weisgerber et al., 2015), suggesting that Study 1 should also show some level of emotion recognition impairment in schizophrenia. However, the cited studies depended on the discrete model emotion, meaning that deficits in the cognitive appraisal and explicit labelling of emotion may have contributed to the reported effects.

Percepts and experiences of musical valences did not consistently differ in individuals with and without schizophrenia. A single observation of reduced emotion identification accuracy for negatively-valenced stimuli (Simon et al., 1951) matched nonmusical findings (Aleman & Kahn, 2005). Five later studies reported either a different relationship between identification accuracy and valence (Abe et al., 2016; Raith et al., 1995; Rossell & Boundy, 2005) or no relationship at all (Dyck et al., 2014; Weisgerber et al., 2015). Experiences of musical valence have also shown signs of normality despite the diagnosis of schizophrenia. Thus, Study 1 should find little evidence for the effect of stimulus valence on musical emotion in schizophrenia.

A series of findings indicated that the arousal and intensity of musical emotions in schizophrenia increase. One study reported that patients with schizophrenia overestimated the arousal of music, irrespective of its valence, and were only sensitive to valence, not arousal, of nonmusical material (Weisgerber et al., 2015). Increased tension (as opposed to relaxation) for musical experiences was also observed (Nielzén & Cesarec, 1982; Nielzén et al., 1993). Spectral EEG (Burge & Siebert, 2010; Günther et al., 1991; 1993) and imaging studies (Dyck et al., 2014) also suggested that musical emotion in schizophrenia increases in arousal and/or intensity. A similar set of effects is expected for Study 1.

Finally, symptomatology and musical symptom-relatedness require some examination. The reviewed studies tended to agree that listener symptomatology did not modulate musical emotions, though non-significant tendencies were observed (e.g. Weisgerber et al., 2015). However, it was suggested that some properties of music connote psychotic symptoms, and that these connotations trigger abnormal music perception (Nielzén & Cesarec, 1982; Nielzén et al., 1993). Study 1 should explore the roles of symptomatology and musical symptom-relatedness.

2.2. Implicit Emotion and Emotional Stroop Performance in Schizophrenia

The overall aim of Study 2 was to evaluate the view that the emotion-paradox of schizophrenia reflects a split between the implicit and explicit processing of emotion. Specifically, this view suggests that implicit emotion processing remains unimpaired by schizophrenia, and that it may overreact to some types of stimuli or some schizophrenic states (Mano & Brown, 2012).

For the purposes of this paper, implicit emotion is defined as a bottom-up process which does not fully traverse into consciousness and is not explicitly regulated (Mano & Brown, 2012). It is an emotion which can influence the subject's attention, cognition, behaviour and psychophysiological response, yet is not consciously appraised and named. Automatic processes subserve the implicit emotion, relative to the more controlled processing of an explicit emotion (Lieberman, 2007). Notably, a preserved implicit emotion may appear heightened when the top-down regulation fails (Mano & Brown, 2012).

Preserved implicit emotion processing in schizophrenia has been suggested across disciplines. For example, explicit and implicit emotion require different working memory resources (Mano & Brown, 2012). Facets of explicit emotion processing, including emotion regulation and the inhibition of attentional interference, require a high working memory load and the support of prefrontal function, both of which diminish in schizophrenia (Mano & Brown, 2012). Implicit emotion is less contingent on the availability of these resources, which may help preserve it (Mano & Brown, 2012).

Social neuroscience also relates the automaticity of implicit emotion and the control over explicit emotion to distinct neural systems, with the former supported by lateral temporal cortex as well as the amygdala, and the latter depending on a relatively higher involvement of cortical and prefrontal structures (Lieberman, 2007). The amygdala, an almond-shaped structure located deep in the temporal lobe, has been in focus of ample research on emotion in schizophrenia. Implicit and explicit emotion processing have been associated with a comparable degree of amygdaloid hypoactivation (Aleman & Kahn, 2005), suggesting that both types of processes should manifest a similar level of impairment in schizophrenia. But as critics pointed out (Aleman & Kahn, 2005; Mano & Brown, 2012), these findings are specific to paradigms in which reaction to emotional and neutral faces are compared. Since neutral facial expressions relate to amygdaloid hyperactivation in individuals with schizophrenia, they may represent an unfair baseline. Indeed, whenever a fixation cross or its equivalent serves as the baseline, amygdaloid function during implicit emotion processing appears preserved or heightened in persons with schizophrenia (Mano & Brown, 2012).

Psychophysiological activity has also been used as an index of implicit emotion processing in schizophrenia. For example, schizophrenia patients showed increased EDA during the implicit processing of emotional faces, suggesting heightened arousal (Williams et al., 2007). However, and as addressed previously (2.1.1), psychophysiological indices may be unsuitable for research on emotion in schizophrenia, owing to the heterogenous modulation of these indices by the disorder.

Study 2 opted for the emotional Stroop task (EST), which has been one of the more common methods of implicit emotion study on the behavioural level. In the original Stroop test (Stroop, 1935), the task is to name the colour of the ink in which a colour-word is written, ignoring the meaning of the colour-word itself. This creates a conflict between the more automatic tendency to read the word and the colour naming, yielding longer reaction times (RTs) or the so-called Stroop effect. Persons with schizophrenia exhibit increased interference on this classic version of the task, which likely reflects the cognitive impairments associated with their disease (Ungar et al., 2010).

In the emotional version of this classic test, participants also identify a neutral characteristic of the stimuli they observe, such as the colour of a word or the gender of a face on a picture. However, the stimuli relay emotion, rather than a semantic incongruence with the neutral characteristic. An EST is thus based on the notion that some types of emotional stimuli automatically capture the attention of some groups of people, and that this change in reactivity reflects onto variations in RTs. An emotional Stroop effect develops in an array of psychiatric disorders, though its expression often varies between and within psychiatric groups. In many affective disorders, emotion-related latencies lengthen, reflecting what is termed interference. In others as well as in neurotic disorders, emotion-related RTs shorten, reflecting what is termed facilitation, or the sensitization toward the emotion (Williams, Mathews, & MacLeod, 1996).

Proponents of the implicit-explicit explanation of the emotion-paradox in schizophrenia utilized the EST in few – but rigorous – studies. A leading study in this field originated from the same research group which first named the emotion-paradox (Aleman & Kahn, 2005). In this study, van't Wout and colleagues (2007) investigated both the implicit and explicit perception of facial emotions in 37 clinically stable patients with schizophrenia and 41 controls matched on age, gender, education, IQ, and even general face processing – as measured by the Benton and Van Allen Test of Facial Recognition (Benton et al., 1983). In the implicit part of the task, participants judged the gender of 80 standardized (Ekman and Friesen, 1976) photographs of faces expressing either: anger, fear, disgust, happiness, or neutral emotion. A 400 ms response window was given. In the explicit part of the task, participants identified anger, fear, happiness or neutral emotion expressed in a different set of 64 visually degraded photographs. Here, no time limit was given.

Results suggested that explicit emotion recognition was impaired in schizophrenia. Specifically, patients made significantly more errors in their judgment of fearful faces. However, no group differences surfaced in the implicit part of the task, in which both patients and controls demonstrated comparable, fear-related interference. Potential associations with positive and negative symptomatology, as measured by PANNS (Kay et al., 1987), were also probed and not observed. The authors suggested that patients with schizophrenia allocate normal (and heightened) automatic attention to facial affect, and only show deficits in the controlled processing of facial affect (van ’t Wout et al., 2007).

Roux and colleagues (2010), who investigated the implicit and explicit perception of prosodic emotions, concurred with the above conclusion. Compared to age- and gender- matched controls, stabilized patients with schizophrenia demonstrated deficits in their explicit recognition of the anger or happiness with which a series of otherwise neutral words were pronounced. But in an EST, in which they listened to words conveying anger or happiness pronounced with angry or joyful prosody, patients showed levels of interference “identical” to controls. The authors concluded that persons with schizophrenia maintain sensitivity to implicit emotional prosody (Roux, Christophe, & Passerieux, 2010).

Note that the tentative preservation of bottom-up processing of emotion is unlikely to extend to other stimulus-driven processes. Indeed, a wide range of generalized and stimulus-specific impairments of perception and low-level attention relate to schizophrenia. For example, patients with schizophrenia exhibit both generalized and face-specific visual attention impairments, making them more prone to err when judging facial features regardless of the emotion that these may express (Darke et al., 2013). The use of appropriate baseline conditions in fMRI studies (Aleman & Kahn, 2005; Mano & Brown, 2012) or the matching of participants on abilities such as general face processing (van ’t Wout et al., 2007) can be of great importance when attempting to evaluate a genuinely emotional effect. While inefficient regulation can play a role in the heightened reactivity to some implicit emotion, the perceptual processing of those can also have an effect, as was suggested in the case of auditory events (2.1.).

Facial and prosodic EST studies provide a fair general conclusion: in schizophrenia, the processing of implicit emotion may be preserved and heightened, despite the impaired and flattened processing of explicit emotion. However, these modified ESTs cannot explore one critical aspect of implicit emotion processing, i.e. the comparative effect of differently valent and/or disorder-related information. Indeed, there are two competing explanations for the emotional Stroop effect: selectivity for highly emotional information (negative or in general) vs selectivity for disorder-related information (Becker, Rinck, Margraf, & Roth, 2001). Importantly, the latter is associated with the exacerbation and maintenance of psychiatric disorders (Williams et al., 1996), which schizophrenia could joint. For example, the type of emotional response to subclinical manifestations of positive symptoms can predict the onset of a psychotic disorder later on (Krabbendam & Van Os, 2005).

By the nature of the material it uses, a word-based EST can compare the effects of valence and disorder-relatedness on changes in response latencies. As such, the task can not only help disentangle the emotion-paradox in schizophrenia, but also specify the conditions in which implicit emotion processing in schizophrenia heightens, and thus conditions which may require more extensive management and therapeutic support.

2.2.1. Review of Emotional Stroop Performance in Schizophrenia

Eight peer-reviewed studies were recovered, which examined performance on the word EST in the extended schizophrenia spectrum. These studies boasted fairly consistent, though at times problematic methodology (Table 4). Patient samples included those diagnosed with schizophrenia, schizoaffective disorder, delusional disorder, acute psychotic disorder, and at times a yet undefined psychotic disorder. Assessment was carried out using the DSM-III or DSM-IV on seven occasion, and ICD-10 in one study. Control and SZ groups were matched on or similar in age and gender, but levels of education, IQ and reading ability differed in some studies. Five research teams employed a card version of the EST, in which series of differently coloured words of the same (blocked) or varied (randomized) emotional content populated a series of A4 cards. Three teams administered the task digitally, and displayed either a single coloured word at a time, or one to four copies of a word (with the number of these copies being the relevant content in this study). While all participants were instructed to respond as quickly and accurately as possible, all but two tasks were fully self-paced. All studies observed overall larger response latencies and error variances in their SZ groups. To correct for this, some used non-parametric tests or log-transformed values, while others opted to calculate the so-called Stroop index (SI) by subtracting RTs to neutral words from RTs to emotion-related words. No studies took advantage of the D-transformation procedure, which can be used to standardize RTs on the basis of within-subjects variability (Greenwald, Nosek, & Banaji, 2003).

Two studies focused on the binary components of emotion - valence and/or arousal – and observed effects akin to those reported in modified EST studies (Roux et al., 2010; van ’t Wout et al., 2007). Demily and colleagues (2009) administered a digital EST composed of neutral, negative, and positive words to 21 clinically stable and medicated patients with schizophrenia, who differed in the extent of negative symptoms. Patients and healthy controls recorded comparable levels of interference towards emotional words. No differences in negative- or positive-related RTs were observed. Furthermore, persons with a higher level of negative symptoms did not perform differently to persons with non-negative symptoms. Linear correlations between anhedonia scores, neuroleptic dosage, and RTs were neither observed. All in all, the researchers could conclude that patients with schizophrenia demonstrated intact implicit emotion processing, even when affected by the most prominent negative symptoms (Demily et al., 2009).

Similarly, Phillips and colleagues (2005) found that patients with schizophrenia or schizoaffective disorder as well as healthy controls showed similar levels of interference toward all negative and positive words of low and high arousal. However, a statistically significant difference emerged between patients with higher and lower levels of disorganization, as measured by the PANNS (Kay et al., 1987). Specifically, disorganized patients were more affected by words of negative valence and high arousal, suggesting aberrant or heightened processing of this kind of implicit emotion (Phillips, Deldin, Voglmaier, & Rabbitt, 2005). However, and in contrast to Demily’s team (2009), Phillips’ failed to exclude words which could connote symptoms of schizophrenia, and thus confound their findings. Indeed, negatively valenced words in this study included potential negative-symptom descriptors, such as “sluggish” or “gloomy,” as well as positive-symptom-related stimuli like “tormented” or “irritable.” Thus, it is unclear, whether arousing negative emotions sensitize disorganized patients, or whether symptom-relatedness also plays a role.

Further six studies centred precisely on the role of symptom-related interference. An early study revealed that inpatients with active persecutory delusions demonstrated significantly longer RTs and larger SIs for paranoia-related words, compared to both a healthy and a psychiatric control group (Bentall & Kaney, 1989). A later series of studies, which both adapted similar stimuli and task design as Bentall & Kaney (1989), corroborated that persons with delusional disorder showed significantly more interference in response to paranoia-related words (Fear & Healy, 1996; Fear, Sharp, & Healy, 1996). The authors added that persons with non-persecutory delusions were also affected by depression- and anxiety-related stimuli (Fear et al., 1996), and that unmedicated patients suffered the greatest interference (Fear & Healy, 1996).

A more recent study also found an association between paranoid delusions and threat-related interference, as measured from a large list of 40 stimuli derived from a standardized battery of different forms of threat-related information (Kinderman, Prince, Waller, & Peters, 2003). But while the task designed by Bentall and Kaney (1989) sported a much smaller set of five stimuli per word category (with their emotion-relatedness pre-rated by only three judges), Kinderman and colleagues (2003) were neither free of methodological issues. In particular, large though reportedly non-significant differences in demographic variables appeared between groups, and some of the 13 members of the patient group have not yet received a diagnosis at the time of their participation. Taken together, however, the four studies present results consistent enough to conclude that persecutory delusions relate to a selective attentional bias to symptom-related stimuli.

This was corroborated by a study which looked into paranoid schizophrenia specifically, rather than persecutory delusions more generally (Besnier et al., 2011). Besnier and colleagues compared 60 healthy controls to 30 patients with paranoid schizophrenia and 30 patients with bipolar disorder, both groups undergoing an acute stage of their disease. Stimuli numbers were limited, with only 4 per the categories of neutral and paranoia-, mania-, and depression-related words. Nonetheless, a significant interaction effect emerged between group-membership and word category, with schizophrenic patients showing the greatest paranoia-related interference, and manic patients showing the greatest mania-related interference. Controls demonstrated similar levels of interference to all affect-laden words.

Finally, a counting Stroop study looked into the effect of general relatedness to major psychiatric disease on the RTs and SIs of 44 patients undergoing acute psychosis and 23 healthy controls (Wiffen et al., 2014). Raw RTs did not significantly differ between groups and word categories, though a near-significant effect was observed with some blocks of trials removed. Specifically, patients tended to record slower RTs when responding to negatively valenced words, while controls appeared to be slowed by the disease-related words. This effect reached significance when SIs were considered in place of RTs. A near-significant correlation was also observed between disease-related interference and insight, such that patients with lower insight seemed less affected by disease-related words. The authors suggested that low insight fostered an implicit defence strategy against related information, which may translate into low interference or even facilitation on the EST (Wiffen et al., 2014).

Table 4. Characteristics of research on EST performance in the extended schizophrenia spectrum.

	Sample				EST Stimuli			Task design	
Study	Healthy controls (*N*)	Psychiatric controls (*N*)	SZ (*N*)	State	Stimuli; selection	*N* trials per emotion	Relevant content (*N*)	Presentation method	Pace + ISI
Bentall & Kaney, 1989	Matched age, gender (16)	Depression (15)	Schizophrenia (9), delusional disorder (7)	Inpatients	Matched length, frequency; pre-rated	5 per nonwords, neu, paranoia, depression	Colour (5)	Card, blocked	Self
Besnier et al., 2011	Similar age, gender, edu (60)		Paranoid schizophrenia (30), bipolar mania (30)	Medicated, inpatients, acute episode	Matched length, frequency; pre-rated	4 per nonwords, neu, paranoia, depression, mania	Colour (5)	Card, blocked	Self
Demily et al., 2009	Matched age, gender (21)		Schizophrenia (21)	Medicated, in/outpatients, stable	Matched length, frequency; pre-rated	25 per nonwords, neu, neg, pos	Colour (3)	Digital (key), randomized	2500ms + 500ms
Fear et al., 1996	Matched age, gender, IQ (20)		Delusional disorder (29)		Matched length, frequency; adapted	5 per nonwords, neu, depression, threat, anxiety	Colour (5)	Card, randomized	Self

	Sample				EST Stimuli			Task design	
Study	Healthy controls (*N*)	Psychiatric controls (*N*)	SZ (*N*)	State	Stimuli; selection	*N* trials per emotion	Relevant content (*N*)	Presentation method	Pace + ISI
Fear & Healy, 1996			Delusional disorder (28)	Half-medicated	Matched length, frequency; adapted	5 per nonwords, neu, depression, threat, anxiety	Colour (5)	Card, randomized	Self
Kinderman et al., 2003	Similar age, gender (13)	Depression (11)	Persecutory delusions (13)		Matched length, frequency, first letter; adapted	40 per neu, threat	Colour	Card, blocked	Self
Phillips et al., 2005	Similar age, gender, diff edu (22)		Schizophrenia, schizoaffective (27)	Most medicated	Matched frequency, length; ANEW	15 per neg/pos valence x low/high arousal + neu	Colour (4)	Digital (vocal), blocked	Self + 1000ms
Wiffen et al., 2014	Matched age, gender, ethnicity, diff IQ (23)		First-episode psychosis (44)	Most medicated	Matched length, frequency; adapted	24 neu, 12 per neg, disorder-related	Number (4)	Digital (key), blocked	1500 / 2000ms

Note. Blank spaces occur in place of missing data or unused variables.

Table 5. Stroop effect in the extended schizophrenia spectrum and its correlation with positive (PS) or negative symptomatology (NS).

			Stroop effect			Correlations	
Study	Groups compared	Analysis	Error-rates	-related RTs	-related SIs	Symptomatology	Medication
Bentall & Kaney,	SZ v. controls &	r-ANOVA (log-				+ PS (magical	
1989	psychiatric controls	transformed)		Paranoia- ↑	Paranoia- ↑	ideation)	
Besnier et al., 2011	SZ v. controls	r-ANCOVA	↑	Paranoia- ↑	Paranoia- ↑	+ PS (PANNS)	=
	SZ v. controls	r-ANOVA	=	=			
Demily et al., 2009	Negative v. non-	Separate r-ANOVA			=	= NS (anhedonia)	=
	SZ v. controls				Threat-related ↑		
	Non-persecutory v.				Depression-,		
Fear et al., 1996	controls				anxiety- ↑		
Fear & Healy, 1996	Non- v. medicated	Kruskal-Wallis			Threat-, anxiety- ↑		-
	SZ v. controls				Threat- ↑		
Kinderman et al.,	SZ v. psychiatric						
2003	controls	Kruskal-Wallis			=		
	SZ v. controls	r-MANOVA	=		=	Neg- x high	
	Disorganized v.	Separate r-			Neg- x high	arousal- + PS	
Phillips et al., 2005	non-	MANOVA	=		arousal- ↑	(disorganization)	
Wiffen et al., 2014	SZ v. controls	Mixed ANOVA	↑	Neg- ~ ↑	Disorder- ~↓	~ + insight	

Note. Symbols denote the following: ↓ decrease; ↑ increase; = no change; ~ this effect only approached sig. or was not statistically assessed.

2.2.2. Summary & Aims

In summary (Table 5), implicit emotion processing as measured by the EST and its modifications appears preserved in schizophrenia, in that it does not reduce or otherwise weaken. This matches the view that the emotion-paradox in schizophrenia reflects a dissociation between explicit and implicit emotion, rather than between percept and experience, but also raises further questions. In particular, EST findings suggest that individuals diagnosed with a schizophrenia spectrum disorder, no matter their symptomatology, can efficiently process an implicit emotion which is unrelated to their concern, no matter its valence. However, patient processing can overreact and heighten when triggered by an implicit emotion related to the individual's disorder or symptomatology.

Implicit processing of negatively valenced emotions appeared comparable between control and SZ groups, in that both displayed mild negativity-related interference (Demily et al., 2009; Phillips et al., 2005). Symptomatology contributed little to these effects. Positive valences appeared similarly unaffected, suggesting that the implicit processing of general emotional salience can persevere in schizophrenia (Demily et al., 2009). Given that these findings match those of modified EST studies (Roux et al., 2010; van 't Wout et al., 2007), Study 2 may expect to concur, finding no significant differences in negativity-related interference between controls and persons with schizophrenia, or between patients with different sets of symptoms.

Some studies suggested that negative valences might gain increased saliency in some conditions, such as when coupled with high arousal (Phillips et al., 2005) or an acute psychosis (Wiffen et al., 2014). These observations could be explained by symptom-relatedness. Indeed, symptom-related emotions appeared to breed heightened reactivity in all EST studies which probed the effect (Bentall & Kaney, 1989; Besnier et al., 2011; Fear & Healy, 1996; Fear et al., 1996; Kinderman et al., 2003). These studies focused on the relation between paranoid symptomatology and paranoia-related interference: patients with paranoia or persecutory delusions displayed a consistent attentional bias towards negatively valenced connotations of the symptoms that they were suffering from the most.

Non-paranoid symptomatology and symptom-relatedness received minimal attention. While it may seem a reasonable expectation that the reported effects extend to general positive symptomatology and general positive-symptom-relatedness – insofar as paranoia constitutes a large part of these – there is an unfortunate little to go on otherwise. One study attempted to examine the relationship between acute psychosis and reactivity to stimuli describing major psychiatric illness but uncovered inconsistent effects (Wiffen et al., 2014). This study observed some evidence of disorder-related facilitation, which Study 2 may hope to replicate. No studies examined symptom-related reactivity in persons with negative symptomatology, or negative-symptom-related reactivity in persons with schizophrenia. Study 2 shall explore these effects in an attempt to determine the generalizability of past EST findings.

Importantly, most studies which examined symptom-relatedness shared at least three critical shortcomings in study design an analysis (Table 4). First, they compared patient reactivity to negatively valent descriptors of symptoms and patient reactivity to neutral stimuli unrelated to those symptoms. This may be an inappropriate baseline condition, which narrows the interpretation of the results: any effects observed ought to be related to the interaction between valence and symptom-relatedness, rather than symptom-relatedness itself. Second, the reviewed studies used potentially questionable methods of score standardization, ranging from log-transformation to an otherwise unexplained removal of some trials. The D-transformation procedure (Greenwald et al., 2003) can be a superior means of within-subjects score standardization, especially in more complex designs (Novakova, 2015). Third, the studies were self-paced, which weakens the applicability of their results to implicit emotion processing. To rectify these shortcomings and to clarify result interpretation, Study 2 adjusted the EST design and analysis, adding categories of symptom-related words of neutral valence, taking advantage of the D-transformation procedure, and restricting the response window.

3. Chapter 3: Research Methods

The overarching aim of this research project was to assess the nature of the emotion-paradox in schizophrenia. This project consisted of two closely related studies (3.2, 3.3). These studies were completed within a single experimental session and were partially counterbalanced across all participants, as shown in Image 1. All in all, they took one hour to complete. Both studies derived from the same sample, as detailed below (3.1.).

The project was approved by the Ethics Committee of the General University Hospital in Prague. Participation was voluntary and anonymous. All participants signed an informed consent form and were debriefed after the experiment. General inclusion criteria specified that participants were to be 18 – 60 years old, have normal or corrected-to-normal hearing and vision, and be fluent speakers of the Czech language. For their safety and comfort, members of the schizophrenia spectrum (SZ) group completed the study in a quiet room located in the clinic that they were recruited from, and a supervising clinician was available throughout their participation.

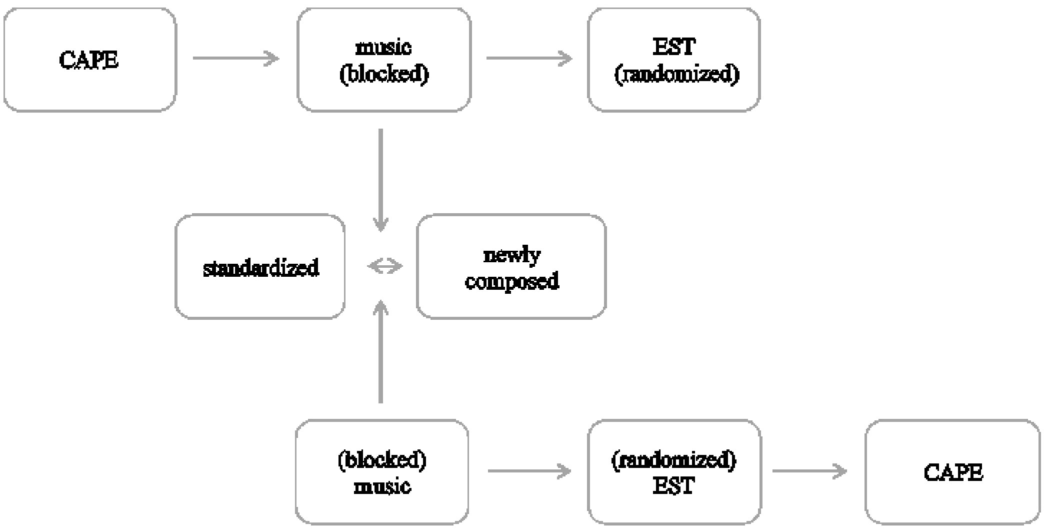


Image 1. Study order was partially counterbalanced.

3.1. Participants

3.1.1. Groups

The SZ group consisted of 45 stabilized patients (21 (46.7%) females; age M = 38.49, SD = 9.69, range = 19 – 63; years of education M = 13.88, SD = 3.68, range = 7 - 22) diagnosed with an ICD-10 psychotic disorder. In total, 27 (60%) persons with schizophrenia (F20), 8 (17.8%) persons with schizoaffective disorder (F25) and 10 (22.2%) persons with an acute psychotic disorder (F23.1 or F23.2) were included in this group, as Figure 1 shows in greater detail. At the time of their participation, 40 patients were hospitalized at the Psychiatry clinic of the Charles University and General University Hospital in Prague, and five were in outpatient care. All patients were referred by a clinician who confirmed their diagnosis and the medication that they used (Table 6).

A control group of 45 volunteers without a psychiatric anamnesis or familial history of a schizophrenia spectrum disorder was selected between the employees and customers of an administrative company. The control group did not differ from the patient group in age (M = 39.53, SD = 11.18, range = 19 – 62), $t(88) = -.474$, $p = .637$, gender (19 (42.2%) females), $\chi 2(1, N = 90) = .180$, $p = .671$, or years of education (M = 14.07, SD = 2.66, range = 9 – 20), $t(78.3) = -.284$, $p = .778$.

The groups did not differ in their highest attained music education, $\chi 2(3, N = 90) = 6.055$, $p = .109$. Most completed compulsory music classes in elementary school (26 (57.8%) patients, 35 (77.8%) controls) and some studied music in high school or privately (13 (28.9%) patients, 9 (20%) controls). Only a few participants had none (3 (6.7%) patients, 1 (2.2%) control) or tertiary music education (3 (6.7%) patients).

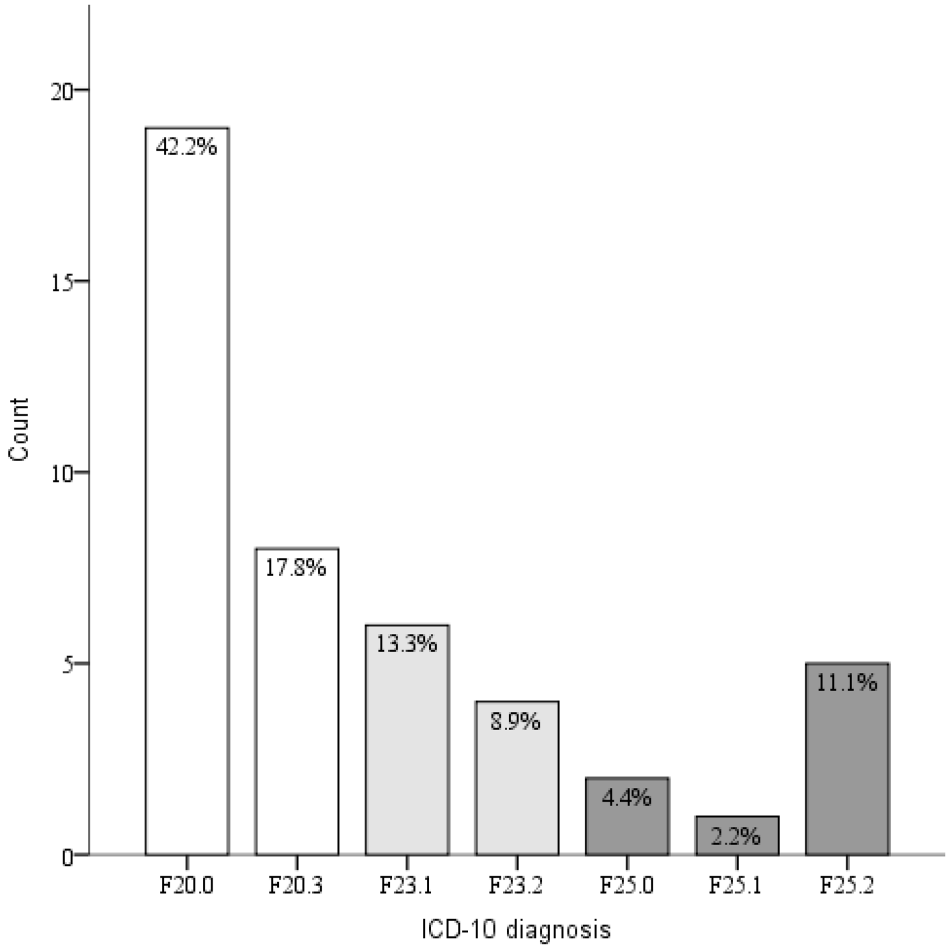


Figure 1. Over one-half of the patients had a schizophrenia diagnosis. Schizoaffective and acute psychotic disorder covered a fifth of the sample each.

Table 6. Medication.

Psychiatric medication		*N* (%) of SZ participants
Atypical antipsychotics		
	Apiprazole	8 (17.8%)
	Clozapine	4 (8.9%)
	Melperone	1 (2.2%)
	Olanzapine	17 (37.8%)
	Paliperidone	11 (24.4%)
	Quetiapine	10 (22.2%)
	Risperidone	4 (8.9%)
	Sulpiride	1 (2.2%)
	Tiapride	1 (2.2%)
Typical antipsychotics		
	Flupentixol	1 (2.2%)
	Fluphenazine	1 (2.2%)
	Haloperidol	8 (17.8%)
Anti-depressants		4 (8.9%)
Anxiolytics		10 (22.2%)
Mood stabilizers		8 (17.8%)

Table 7. CAPE score distribution per scale and per group.

	CAPE-pos			CAPE-neg			CAPE-dep			CAPE-42		
Group	*M* ± *SD*	Skew (*SE*)	Kurtosis (*SE*)	*M* ± *SD*	Skew (*SE*)	Kurtosis (*SE*)	*M* ± *SD*	Skew (*SE*)	Kurtosis (*SE*)	*M* ± *SD*	Skew (*SE*)	Kurtosis (*SE*)
Controls	1.30 ± .18	.87 (.35)	.68 (.70)	1.63 ± .26	-.03 (.35)	.47 (.70)	1.69 ± .28	.26 (.35)	-.61 (.70)	1.54 ± .20	.20 (.35)	-.36 (.70)
SZ	1.78 ± .55	1.36 (.36)	2.62 (.70)	2.04 ± .41	.19 (.36)	.46 (.70)	2.16 ± .59	.52 (.36)	-.16 (.70)	1.99 ± .44	.40 (.36)	.05 (.70)
Total		1.99 (.26)	5.34 (.51)		.60 (.26)	.69 (.51)		1.10 (.26)	1.19 (.51)		1.05 (.26)	1.05 (.51)

3.1.2. Symptomatology assessment

This study relied in part on the Community Assessment of Psychic Experience (CAPE) (Stefanis et al., 2002) as a means of symptomatology assessment. The CAPE consists of 42 questions designed to measure the frequency with which individuals experience positive (20 items), negative (14 items), and depressive symptoms (8 items), and the distress that these experiences cause them. Each CAPE item consists of two four-point Likert scales. A sum of responses to the frequency and distress components of all questions within each scale yields two total scores and two scores per each of the three scales. These scores are then converted back to the 0 - 3 range to improve their readability and to account for partial non-response. Weighted scores refer to the average of the frequency and distress component of the score given.

A Czech version of the CAPE was validated with 215 online respondents and showed high internal consistency, as well as good criterion and construct validity (see Kerkova, 2018 for more details). However, the instrument's factor validity was questionable (CMIN/df = 1.587, RMSEA = .052, CFI = .911, TLI = .907), as was the case with all past versions of the CAPE (Mark & Toulopoulou, 2016). For this reason, it is typically recommended that the instrument be used in full and that the interpretation of its results focuses on either overall scores or the positive frequency or weighted score since these scores alone can reach more acceptable goodness-of-fit values (Mark & Toulopoulou, 2016).

Participants completed the Czech version of the CAPE, along with a short demographic questionnaire (Appendix A). One patient refused to complete the questionnaire. Table 7 presents recalculated weighted scores per scale and per group. Scores tended towards positive skew though they maintained fair symmetry in each group separately. Excess kurtosis values were acceptable for all but the CAPE-pos scale. Overall frequency scores reached Cronbach's alpha of .917, indicating high internal consistency. Alpha values above .900 may indicate item redundancy, but no inter-item correlation of excess strength (> .800) were observed. CAPE-pos (α = .905), CAPE-neg (α = .780), and CAPE-dep scores (α = .797) also demonstrated good internal consistency.

All in all, CAPE-42 scores were significantly higher in the SZ compared to the control group, $t(59.2) = 6.176$, $p < .001$. Item 1 was the most popular in both groups; all controls and 42 (95.6%) patients experienced sadness at least sometimes. As Table 8 details, social delusions, social withdrawal, and lethargy were among the most commonly experienced symptoms in the SZ group.

Table 8. The most and the least popular CAPE-pos and CAPE-neg items. The table lists the number and the valid percent of group members who reported having at least some experience with the item.

Scale	Item	SZ *N* (valid %)	Controls *N* (valid %)
CAPE-pos	7: Persecution	28 (63.6%)	16 (35.6%)
	13: Being special	27 (64.3%)	17 (37.8%)
	6: Deception	26 (59.1%)	32 (71.1%)
	2: Double meanings	25 (56.8%)	24 (53.3%)
	20: Voodoo	24 (57.1%)	14 (31.1%)
	…		
	41: Visual hallucinations	3 (7.0%)	4 (9.1%)
CAPE-neg	21: Low energy	38 (90.5%)	38 (84.4%)
	4: Not talkative	36 (91.8%)	21 (46.7%)
	36: Unfinished tasks	34 (79.1%)	26 (57.8%)
	16: Social withdrawal	33 (78.6%)	31 (68.8%)
	18: Lacking motivation	31 (73.8%)	38 (84.4%)
	…		
	8: No emotion	18 (40.9%)	27 (60.0%)

3.1.3. Subgroups

For parts of the analysis, the SZ group was split into three subgroups: a positive-symptom subgroup (PS), a negative-symptom subgroup (NS), and an acute psychosis subgroup. Group assignment followed two steps, and adhered to ICD criteria first. All persons with a diagnosis of paranoid schizophrenia ($N = 19$) or manic schizoaffective disorder ($N = 2$) automatically proceeded to the PS subgroup, and everyone with an acute psychotic disorder ($N = 10$) proceeded to the acute psychosis subgroup. Only one person, with depressive schizoaffective disorder, could be auto-assigned to the NS subgroup.

Step two concerned persons with undifferentiated schizophrenia ($N = 8$) and mixed schizoaffective disorder ($N = 5$). These were assigned to the PS or NS subgroup based on their CAPE scores. Those who have exceeded a weighted positive score of 2.0 or who have received more positive than negative points were considered PS ($N = 3$); others were classed within the NS group ($N = 10$).

In total, there were 24 members of the PS group, 11 members of the NS group and 10 members of the acute group. Table 9 lists the characteristics of the three subgroups: they did not significantly differ in age, $F(2, 42) = .198$, $p = .821$, gender, $\chi2(2, N = 45) = 3.004$, $p = .223$, or years of education, $F(2, 41) = 1.816$, $p = .175$.

Table 9. Subgroup characteristics.

Subgroup	Age *M* ± *SD*	*N* (%) of females	Education *M* ± *SD*	CAPE-42 *M* ± *SD*
PS	39.33 ± 10.21	9 (37.5%)	12.98 ± 3.65	2.12 ± .47
NS	37.82 ± 7.88	5 (45.5%)	14.45 ± 3.50	2.01 ± .33
Acute	37.20 ± 10.94	7 (70.0%)	15.45 ± 3.62	1.62 ± .23

To check that subgroup assignment was meaningful, a MANOVA was conducted for CAPE-pos, CAPE-neg, and CAPE-dep scores. While Box's M-value of 29.658 was not significant at less than .001 (p = .012), Pillai's trace statistic was still preferred given the small and unequal sample sizes. Error variances did not significantly differ between subgroups, as per Levene's tests and Hartley's variance ratios.

A statistically significant main effect of group on the combined scores emerged, $V = .432$, $F(6, 80) = 3.670$, $p = .003$, $\eta^2 = .216$, persisting for: CAPE-pos, $F(2, 41) = 7.031$, $p = .002$, $\eta^2 = .255$; CAPE-neg, $F(2, 41) = 4.011$, $p = .026$, $\eta^2 = .164$; and CAPE-dep, $F(2, 41) = 3.571$, $p = .037$, $\eta^2 = .148$. Figure 2 present the distribution of these scores between the subgroups. Note that the PS subgroup reached the highest CAPE-pos score and the CAPE-neg subgroup reached the highest CAPE-neg score, whilst the acute psychosis subgroup reported the lowest scores on all scales. Post-hoc comparisons using the Tukey HSD test suggested that the PS subgroup had significantly higher CAPE-pos scores than the NS subgroup, $p = .043$, and the acute subgroup, $p = .004$. The NS subgroup had significantly higher CAPE-neg scores than the acute subgroup, $p = .019$, but not the PS subgroup, $p = .338$. As for CAPE-dep scores, the only statistically significant difference emerged between the PS subgroup and the acute subgroup, $p = .031$.

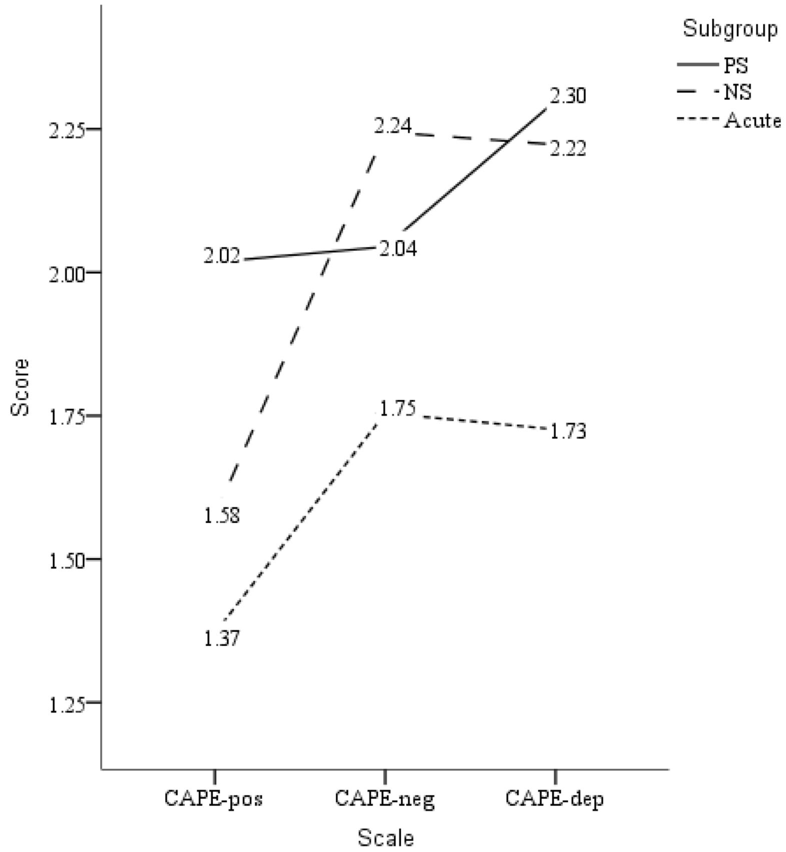


Figure 2. The three subgroups reached different CAPE-pos, CAPE-neg, and CAPE-dep scores, suggesting that subgroup assignment was meaningful.

3.2. Study 1: Musical Emotions

Study 1 employed a repeated-measures design to define the perception and experience of musical valence and arousal in persons with and without schizophrenia. Specifically, the study aimed to:

1. Assess the association between perceived and experienced musical emotion, and the extent to which this association may differ in persons with and without schizophrenia, anticipating that:
    1.1. the perception and experience of musical emotions in schizophrenia will not show a dissociation,

1.2. both musical percepts and experiences will not be affected by stimulus valence,

1.3. both musical percepts and experiences will show greater arousal or intensity.

2. Compare musical emotion recognition in persons with and without schizophrenia.
3. Explore the roles of symptomatology and musical symptom-relatedness.

3.2.1. Procedure

A variant of this task was piloted with 10 volunteers. Minor changes in design were made, as accounted for below.

The task was designed in OpenSesame (v. 3.1) (Mathôt, Schreij, & Theeuwes, 2012) using a legacy backend and elaborate Python scripting. Participants were seated at a comfortable chair in front of a laptop computer and fitted with sound-proof Razer Kraken headphones, connected to a DragonFly digital-to-analogue converter and amplifier.

At the start of the task, participants completed a digitalised version of the Music Engagement Style I (MES-I) questionnaire. The MES-I originates from the Music Use questionnaire (MUSE) and consists of seven questions which assess the extent to which a listener uses music to bring about the desired level of cognitive performance or emotional state (Chin & Rickard, 2012). MES-I items are administered in the form of five-point Likert scales by which participants express their agreement with the statements provided (e.g. "I use a particular type of music to get me through tough times.").

Next, participants were instructed to carefully listen to each musical stimulus and rate both the perceived and experienced valence and arousal of each. Perceived emotion was defined as the emotion that the music objectively transmits; experienced emotion was defined as the emotion that the participant subjectively feels whilst listening. On-screen instructions were supplemented by a pictorial hand-out (Appendix B), and participants were encouraged to ask questions before or during the task, should the procedure be unclear to them.

The task counted 18 trials, separated into two blocks of a counterbalanced order. Within a trial, a random musical stimulus played on a loop with a two seconds intermission, until the participant submitted their rating. An interactive variant of the affect grid (Russell, 1980) was used to record these ratings (Image 2). Participants right-clicked within the affect grid to enter a perceived emotion rating (denoted by an icon of an ear) and left-clicked to enter an experienced emotion rating (denoted by an icon of a heart). Ratings were self-paced and could be changed if desired.

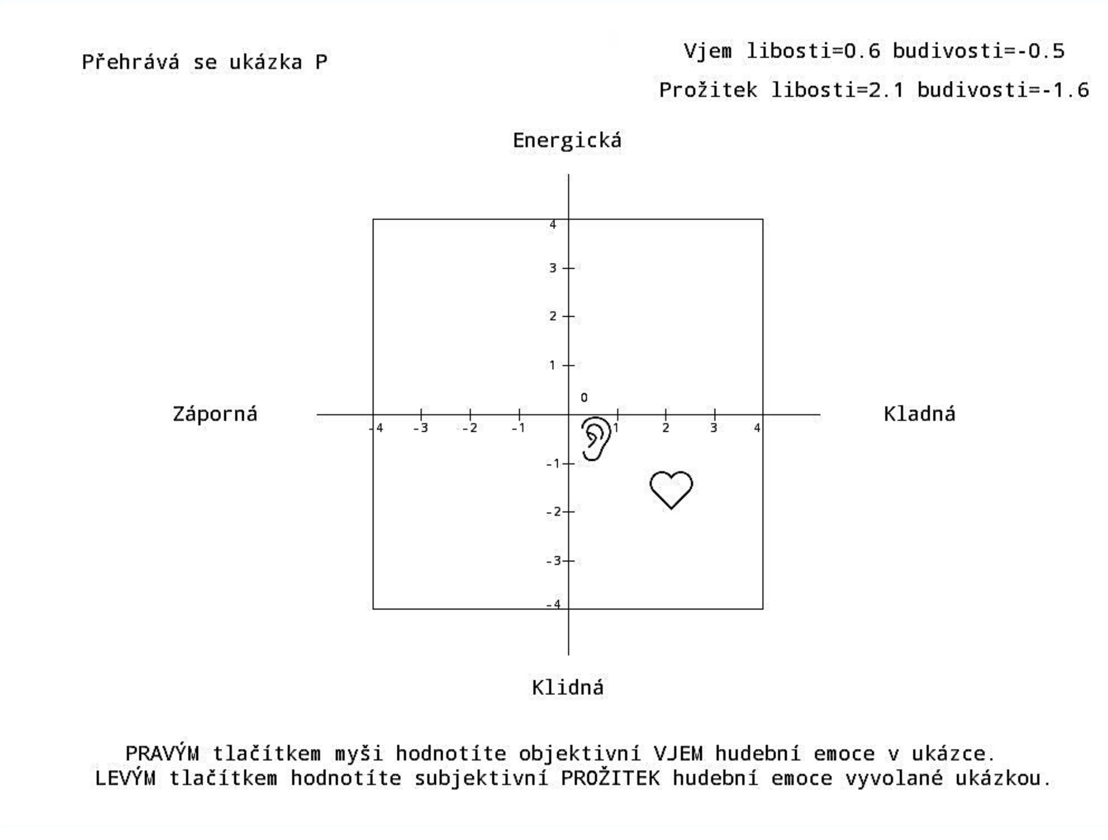


Image 2. An example of a trial.

3.2.2. Material

Experimental stimuli were 15 – 25 s long samples of instrumental music presented in a .wav format. Participants were able to adjust the volume to a level comfortable to them. Nine control stimuli originated from a standardized battery of unfamiliar film music (Eerola & Vuoskoski, 2011). These were selected to represent combinations of negative, high and moderate valence and arousal (Table 10). In some cases, an ideal match was unattainable. For example, the best fit to a stimulus that would be low in valence and low in energy was noticeably higher in arousal than in valence; this possibly reflects the intrinsically arousing quality of extremely low valences (Eerola & Vuoskoski, 2011).

Table 10. The valence and arousal of standardized stimuli.

Excerpt ID	Album, Track No.	Length (s)	Emotion level	Valence *M*	Arousal *M*
L	The Alien Trilogy, 9	16	VN:AH	-2.02	3.21
O	The Fifth Element, 9	16	VN:AM	-1.97	0.12
J	Grizzly Man, 16	17	VN:AN	-2.96	-0.46
R	Crouching Tiger, Hidden Dragon, 8	15	VM:AH	-0.10	3.00
P	Naked Lunch, 7	16	VM:AM	0.46	-0.22
N	Pride & Prejudice, 13	16	VM:AN	0.37	-2.72
M	Oliver Twist, 8	25	VH:AH	2.75	3.08
Q	The Godfather III, 5	17	VH:AM	2.09	-0.79
K	Shine, 10	19	VH:AN	2.27	-1.15

Note. V is "valence", A is "arousal", and subscript letters N, M, and H denote “negative”, “moderate”, and “high”, respectively. Values were recalculated from an originally reported 1 - 9 range.

Nine exploratory stimuli were newly composed based on theoretical insights so that they sonically simulated positive and negative symptoms of schizophrenia (Table 11). For example, stimulus A (Image 3) connoted catatonia-like negative symptoms by means of a heavy B minor melody, slow 70 BPM rhythm, the use of reverb, delay and distortion effects on instruments, and an application of stretch, tape-stop and bit-crush effects to the master. The stimuli were composed in FL Studio (v. 12) (Dambrin, 1997) in cooperation with Dr Tim Metcalfe, a psychoacoustics specialist.

Image 3. Stimulus A score.

A pre-test with 35 healthy participants (26 females, Age M = 28.09, SD = 8.50) was conducted to check if the arousal and valence of standardized and newly composed stimuli matched. Table 11 presents the results. Stimuli C, E, and A underwent minor edits to improve their accordance with the standardized stimuli. For example, the main melody line of stimulus A was lowered in volume and slowed down, thus further decreasing the arousal of the stimulus.

Table 11. The valence and arousal of newly composed stimuli and their deviations from standardized stimuli. Output of a pre-test with 35 healthy participants.

Excerpt ID	Length (s)	Emotion level	Valence *M* ± *SD*	Valence *t*	Arousal *M* ± *SD*	Arousal *t*
C	15	V_N:E_H	-.42 ± 2.33	4.223***	2.63 ± 1.60	-2.150*
F	18	V_N:E_M	-1.52 ± 1.83	1.440	-1.64 ± 1.80	-5.769***
A	21	V_N:E_N	-2.32 ± 1.75	2.149*	.15 ± 2.35	1.542
I	15	V_M:E_H	-.42 ± 1.82	1.036	1.33 ± 2.10	-4.705***
G	22	V_M:E_M	-.15 ± 1.93	-1.873	-.72 ± 1.75	-1.702
E	17	V_M:E_N	1.11 ± 1.57	2.774**	-1.98 ± 1.60	2.739*
D	23	V_H:E_H	1.98 ± 2.11	-2.161*	2.51 ± 1.36	-1.023
H	15	V_H:E_M	1.22 ± 1.78	-2.891**	.27 ± 1.54	4.045***
B	18	V_H:E_N	.57 ± 1.95	-5.159***	-1.26 ± 2.17	- *.292*

Note. V is "valence", A is "arousal", and subscript letters N, M, and H denote “neutral” moderate and high, respectively.
****p* < .001, ***p* <.01 level, **p* <.05 level

3.2.3. Analysis

All analysis was conducted in SPSS (v. 21.0). The data were checked for normality and chi-square and independent *t*-tests assessed between-group differences in demographics and MES-I scores. A series of repeated-measures MANOVAs probed between-group differences in musical emotion recognition accuracy, the strength of the music perception-experience association, and musical emotion intensity. Previous studies on musical emotion in schizophrenia raised some support for the *null* hypotheses, that persons with and without SZ do *not* differ in their ability to recognize musical emotion, and that persons with and without SZ do *not* perceive and experience musical emotions differently. To aid in the interpretation of potentially non-significant effects – and the probability of Type II error associated with them –

the smallest effect of interest (SESOI) was set to $\eta 2$ = .100 following the Cohen convention (Cohen, 1988). Effect sizes are thus reported for all significant and non-significant effects, where relevant.

3.3. Study 2; Emotional Stroop Performance

Study 2 adapted the EST for persons with a psychotic disorder and examined their performance. The repeated-measures design explored group and subgroup differences in reactivity to general and symptom-related threat. Specifically, the study aimed to:

1. Compare negativity-related interference in persons with and without schizophrenia, and in patients with various symptomatology, anticipating no statistically significant differences between groups or subgroups.
2. Compare symptom-related interference in persons with and without schizophrenia, and in patients with various symptomatology, anticipating that:
   2.1. Persons with the greatest PS display the greatest PS-related interference,
   2.2. Persons undergoing an acute psychosis show signs of symptom-related facilitation,

   and exploring:

   2.3. NS-related variations in RTs between groups and subgroups,
   2.4. Symptom-related effects in persons with the greatest NS.

3.3.1. Procedure

The EST was designed in OpenSesame (v. 3.1) (Mathôt et al., 2012) using a psycho backend and minor Python scripting. The task counted 30 practice and 360 experimental trials. Participants were presented with a series of words and indicated the colour of each word (red, green, or blue) by pressing a relevantly coloured key (Q, W, E) on the keyboard of a laptop computer. Participants were instructed to answer as quickly and accurately as possible. Each trial was preceded by an inter-trial-interval of a random 1000 ms or 2000 ms length. Stimuli appeared on-screen in a 32 px (24 pt) Mono font until a response occurred or for a maximum response period of 1000 ms. Stimulus presentation was fully randomised.

3.3.2. Material

The EST included three blocks of emotionally threatening words derived from the Affective Norms for English Words set (ANEW) (Bradley & Lang, 1999) and secondary sources. First, generally threatening words were used (Demily et al., 2009; Phillips et al., 2005). The next two categories included medical and phenomenological descriptors of positive (Bentall & Kaney, 1989; Besnier et al., 2011) and negative symptoms of schizophrenia (Martin et al., 1991; Mattia et al., 1993).

A list of 30 threatening words was compiled per each category and translated to the Czech language. Emotionally neutral counterparts were selected so that they matched in word type, word length, and frequency; the latter was checked against the electronic version of the Frequency Dictionary of Spoken Czech (Frekvenční slovník mluvené češtiny) (Čermák, 2007). These words were then submitted to a pre-test, in which 20 healthy participants (9 females, age M = 40.90, SD = 11.85) rated their valence on a 1-9 Likert scale. Words which received mean ratings of ambiguous valence (i.e. at the upper borders of negative valence (3.7 points) or neutral valence (6.3 points)) were removed. To ensure that all categories matched (Table 12), some other words underwent minor edits (e.g. pluralization as a means of increasing word length). This procedure resulted in a final list of 20 negative words and 20 neutral words in each of the three categories, or 120 words in total (Appendix C). Within each condition, each word was presented once in each of the three colours.

Table 12. EST Stimuli.

Category		*N* of nouns	Word length *M* ± *SD*	Frequency *M* ± *SD*	Valence *M* ± *SD*
Positive-symptom-related	Negative	16	5.80 ± 1.54	6.50 ± 12.65	3.00 ± .35
	Neutral	14	5.70 ± 1.59	6.55 ± 9.25	4.99 ± .66
Negative-symptom-related	Negative	14	5.95 ± 1.61	6.10 ± 7.93	3.22 ± .44
	Neutral	14	5.75 ± 1.29	7.05 ± 11.70	4.92 ± .63
Control	Negative	15	5.70 ± 1.17	6.20 ± 11.24	2.99 ± .34
	Neutral	16	5.95 ± 1.64	6.50 ± 8.75	4.94 ± .47

Note. The letter ‘ch’ was counted as two letters when computing word length.

3.3.3. Analysis

Data were prepared using Microsoft Excel macros (e.g. removal of diacritical marks), collated, and sent to SPSS (v. 21.0) for analysis. Mean RTs were calculated for each word category, with error or missed responses and trials in which the RT fell more than 2 SDs from the participant’s mean RT removed.

These scores were standardized on the basis of within-subjects variability, in order to control for the general cognitive impairment in schizophrenia (Besnier et al., 2009; Demily et al., 2010), as well as RT variability between individuals. A D-transformed Stroop Index (D-SI) (Greenwald et al., 2003) was calculated for each word category using the following equation (1):

$$\text{D-SI} = \frac{(\text{mean RT for negative words} - \text{mean RT for neutral words})}{\text{pooled SD for negative and neutral words}} \quad (1)$$

This procedure yielded three new variables, which reflected interference (positive values) or sensitization (negative values) towards negative control, PS-related, or NS-related words. The variables were submitted to a 3*2 repeated-measures ANCOVA, with group membership as a between-subjects factor, symptom-relatedness as a within-subjects factor, and CAPE-42 as a covariate. Next, a separate 3*3 repeated-measures ANOVA explored differences between the SZ subgroups.

4. Chapter 4: Results

4.1. Study 1; Musical Emotions

4.1.1. Data Distribution

Data were checked for normality using histograms and steam-leaf plots. Ten consistent outliers were identified. Out of these, four patients and four controls clearly misunderstood the task. These participants placed all their ratings on the two axes, instead of using the affect grid in its entirety, meaning that they only submitted a valence or an arousal rating of the emotion they perceived or experienced. An additional member of each group submitted the same rating for each excerpt, suggesting non-compliance with the task. These participants were excluded from the analysis. Further two patients and one control made errors in parts of the task, which they reported to the experimenter during their sessions. These errors were logged as missed responses.

In total, 40 patients with schizophrenia and 40 controls were included in the analysis. No significant differences in demographic variables emerged (age: $p = .546$, gender: $p = .499$, general education: $p = .839$, music education $p = .304$).

4.1.2. MES-I

The control group ($M = 17.68$, $SD = 5.31$) as well as the SZ group ($M = 20.53$, $SD = 4.24$) indicated that, on average, they often engaged with music for the purposes of cognitive or emotional regulation. Patients scored significantly higher, $t(78) = 2.570$, $p = .012$, suggesting that this variable required closer inspection. A significant positive correlation was observed between CAPE-42 and MES-I scores, $r = .324$, $p = .004$, though this did not prevail per either group alone (SZ: $p = .087$, controls: $p = .269$) (Figure 3).

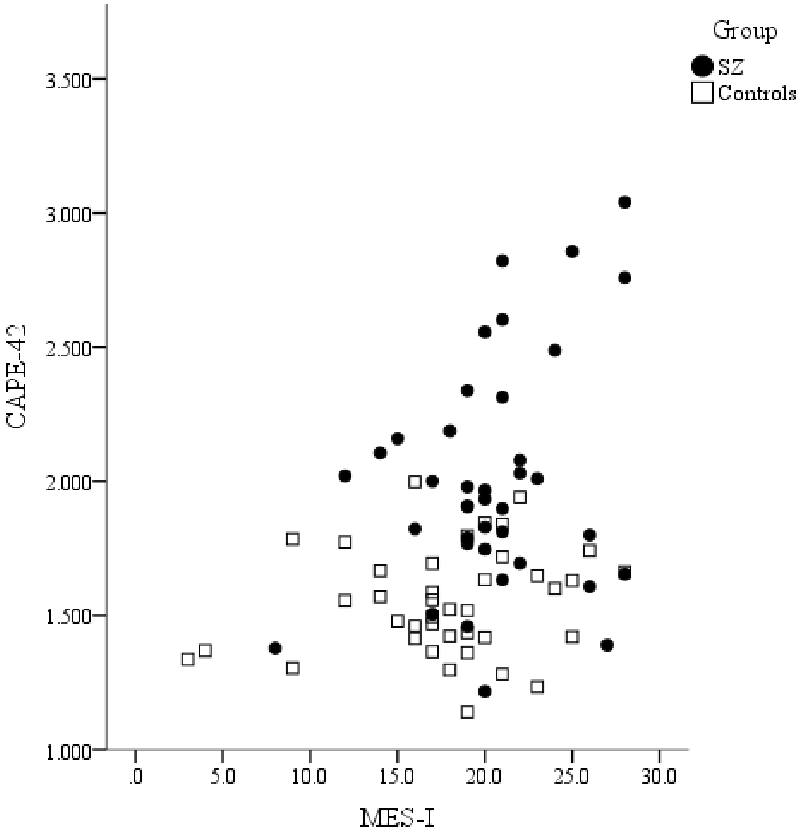


Figure 3. The positive correlation between CAPE-42 and MES-I did not persist for either group alone.

4.1.3. Emotion Perception and Recognition

4.1.3.1. Standardized stimuli.

Mean perception ratings are available in Appendix D. Accuracy was calculated by subtracting the population mean rating of each excerpt (Table 10) from the rating observed. Thus, accuracy was the highest for scores which approached zero. Positive accuracy scores reflected overestimation (a rating that was more positive than assumed), and negative accuracy scores reflected underestimation (a rating that was more negative than expected).

A two-way repeated-measures MANOVA with group as a between-subjects factor and stimulus valence and arousal as within-subjects factors was run for the two measures: valence accuracy and arousal accuracy. The Box's *M*-value of 261.20 was not significant (p = .096), suggesting that equal covariance matrices between groups could be assumed. Multivariate tests indicated that neither group provided significantly more accurate ratings (p = .165, $\eta 2$ = .047), with patients (M = -.141, SD = .602) and controls (M = -.162, SD = .521) attaining comparable accuracy overall. Groups also performed similarly at the different levels of stimulus valence (p = .568, $\eta 2$ = .039), arousal (p = .069, $\eta 2$ = .111), and their combinations (p = .414, $\eta 2$ = .108).

Since sphericity could not be assumed for the effect of stimulus valence on valence accuracy, $\chi^2(2) = 10.346$, $p = .006$, and the effect of stimulus arousal on arousal accuracy, $\chi^2(2) = 23.401$, $p < .001$, a Huynh-Feldt correction (ε = .917, and ε = .813, respectively) was applied to the relevant results. Within-subjects analysis corroborated that neither valence nor arousal accuracy alone differed between groups at the varying levels of stimulus valence (p = .534, $\eta 2$ = .008; p = .528, $\eta 2$ = .008), stimulus arousal (p = .158, $\eta 2$ = .024; p = .309, $\eta 2$ = .015), and their combinations (p = .192, $\eta 2$ = .020; p = .691, $\eta 2$ = .007).

A main effect of group on valence (p = .129; $\eta 2$ = .030) or arousal accuracy (p = .178; $\eta 2$ = .024) was also not observed. However, Levene's test indicated that between-group variances were unequal for some of the excerpts. This concerned the accuracy of the valence ratings of two of the most negative excerpts, excerpt J, $F(1, 76) = 12.918$, $p = .001$, and excerpt O, $F(1, 76) = 4.804$, $p = .031$.

All in all, valence and arousal accuracies were only affected by the stimuli's actual valence and arousal. That is, all participants tended to overestimate valences, especially if these were negative, $F(1.8, 139.4) = 41.736$, $p < .001$, $\eta 2$ = .354, and underestimate arousals, especially if these were positive, $F(1.63, 123.59) = 22.744$, p

$< .001$, $\eta 2 = .230$. This tendency to overestimate valence and underestimate arousal appeared more pronounced amongst patients (Figure 4).

As Figure 4 further illustrates, stimulus valence also modulated arousal accuracy, $F(2, 152) = 19.059$, $p < .001$, $\eta 2 = .200$, while stimulus arousal modulated valence accuracy, $F(2, 152) = 11.421$, $p < .001$, $\eta 2 = .131$. Naturally, the valence x arousal interaction effect was significant for both valence accuracy, $F(4, 304) = 9.658$, $p < .001$, $\eta 2 = .113$, and arousal accuracy, $F(4, 304) = 10.008$, $p < .001$, $\eta 2 = .116$. Since these effects were of little interest to this study, they were not probed in greater detail.

In order to probe potential differences between persons with PS, NS, and acute psychosis, data were reduced to two variables: average valence accuracy, and average arousal accuracy. A MANOVA indicated no significant subgroup differences overall ($p = .208$), or for valence and arousal accuracy alone ($p = .424$, $p = .119$, respectively). No evidence for violated assumptions was observed.

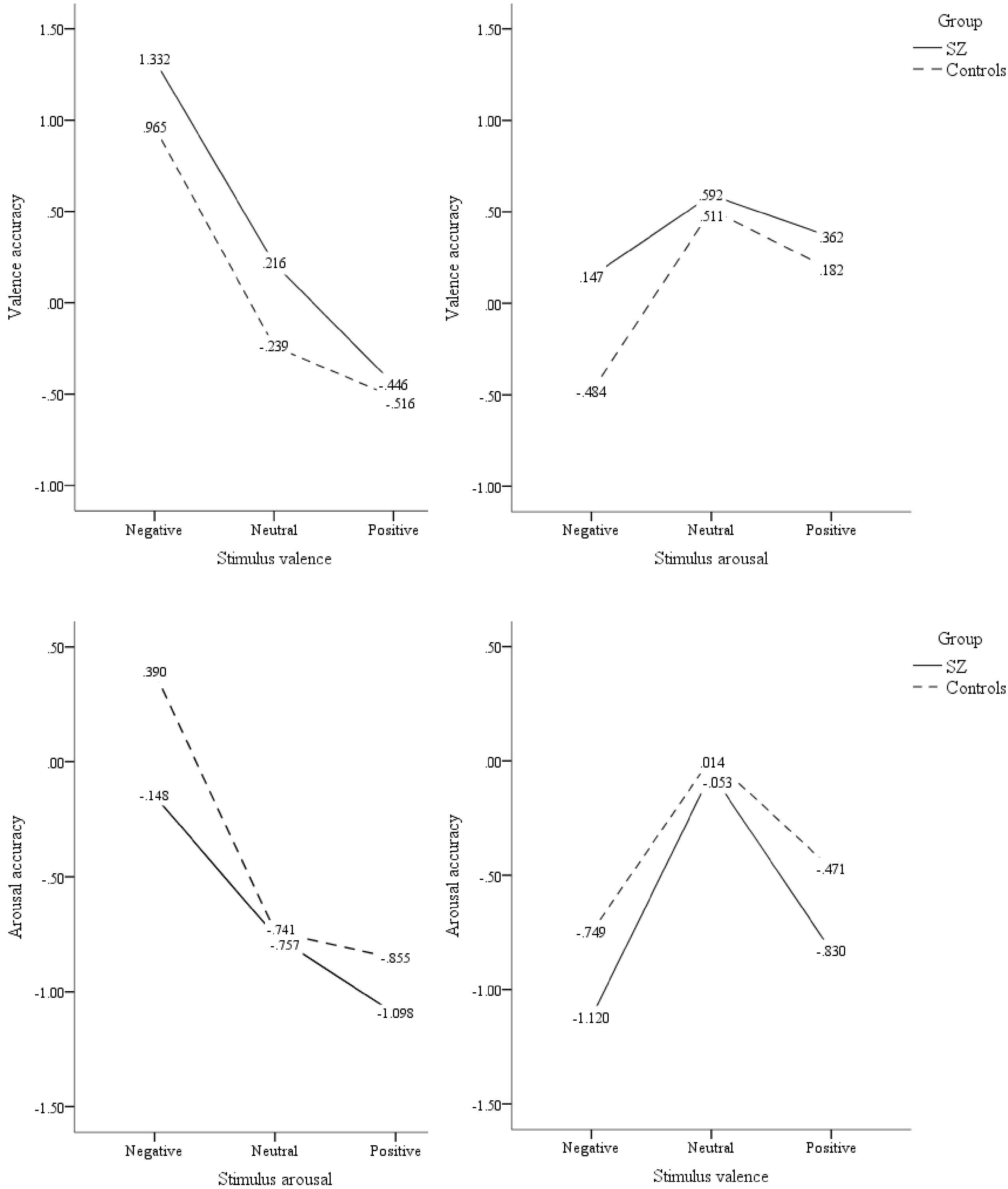


Figure 4. Persons with and without schizophrenia overestimated valence and underestimated arousal.

4.1.3.2. Newly composed stimuli.

Since no standardized ratings of newly composed stimuli were available, their recognition was explored separately, so as not to convolute the results above with the questionable validity of the ones below. Accuracies were computed using the same population means (Table 10), following the assumption that the two stimulus types indeed matched in valence and arousal. These values were then submitted into a new repeated-measures MANOVA. For brevity sake, only main and interaction effects of group are reported.

Homogenous covariance matrices could be assumed, $M = 252.220$, $p = .183$. The main MANOVA found a significant main effect of group on the combined accuracies, $V = .133$, $F(2, 74) = 5.691$, $p = .005$, $\eta^2 = .133$, as well as a stimulus valence x group interaction effect, $V = .157$, $F(4, 72) = 3.471$, $p = .014$, $\eta^2 = .157$, and a stimulus arousal x group interaction effect, $V = .259$, $F(4, 72) = 3.471$, $p < .001$, $\eta^2 =$ .259.

Sphericity could be assumed for all results which follow. Follow-up analysis specified that the stimulus valence x group interaction effect was not significant for either valence accuracy ($p = .063$, $\eta 2 = .036$) or arousal accuracy ($p = .113$, $\eta 2 = .029$) alone. Repeated contrasts suggested that a significant group difference in the recognition of neutral compared to positive valences may have prevailed, $F(1, 75) =$ 7.289, $p = .009$, $\eta^2 = .089$. As Figure 5 illustrates, controls tended to be less accurate in that they overestimated neutral valences and underestimated positive valences.

The stimulus arousal x group interaction effect remained significant for arousal accuracy, $F(2, 150) = 10.871$, $p < .001$, $\eta^2 = .127$, but not valence accuracy alone ($p = .398$, $\eta 2 = .017$). Repeated contrasts specified a significant group difference in the recognition of neutral versus positive arousals $F(1, 75) = 13.976$, $p < .001$, $\eta^2 = .157$. As per Figure 5, controls again overestimated neutral arousals whilst underestimating positive arousals.

Levene's test indicated that group variances were unequal for the valence accuracies of excerpt C, $F(1, 75) = 5.671$, $p = .020$, and arousal accuracies of excerpt A, $F(1, 75) = 4.632$, $p = .035$, excerpt G, $F(1, 75) = 8.261$, $p = .005$, and excerpt D, $F(1, 75) = 5.995$, $p = .017$. Hartley's variance ratio surpassed its critical value for excerpt D only, reaching $F_{Max} = 4.041$. Unequal variances may have compromised the accuracy of the following F-test. The main effect of group appeared to remain significant for arousal accuracy, $F(1, 75) = 11.514$, $p = .001$, $\eta^2 = .133$, with controls tending to overestimate arousal overall, *M* = .326, *SD* = .771, and patients tending to underestimate it, *M* = -.266, *SD* = .880. Overall valence accuracy did not significantly differ between groups ($p = .863$), with controls, *M* = .218, *SD* = .647, and patients, *M* = .223, *SD* = .932, reaching similar results.

An explorative MANOVA was conducted as before (4.1.3.1.) and found no significant subgroup differences overall ($p = .413$), or in average valence and arousal accuracy separately ($p = .635$, $p = .187$, respectively).

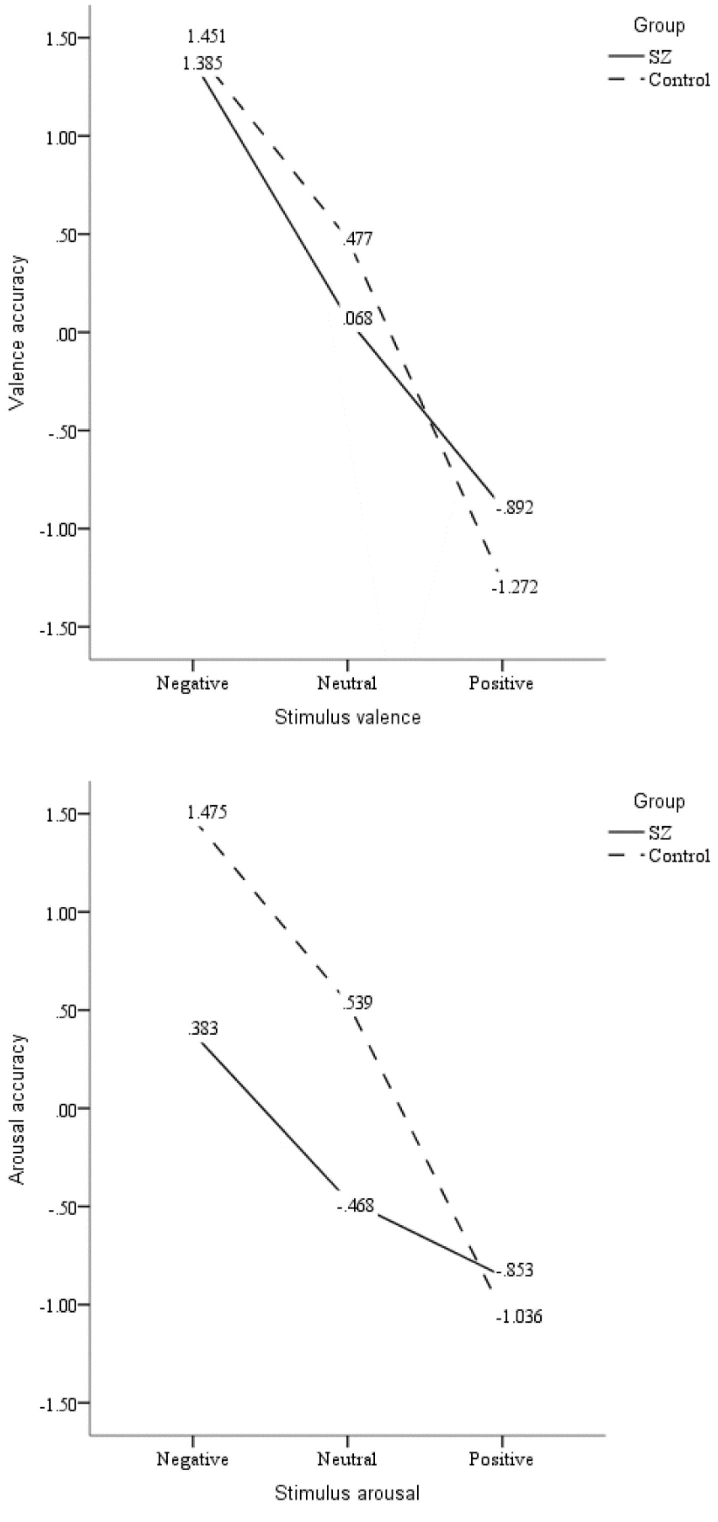


Figure 5. Controls provided less accurate ratings of the newly composed stimuli.

4.1.4. Emotion Experience and the Emotion-Paradox

Appendix D lists raw experience ratings per excerpt and group. Exploratory multiple regressions revealed that, irrespective of group membership, the experience of valence was explained by the perception of valence rather than the perception of arousal (Table 13), and that the experience of arousal was explained by the perception of arousal but not the perception of valence (Table 14). Going forward, the latter variables were dropped.

Table 13. Experienced valence is predicted by perceived valence rather than perceived arousal.

	Standardized stimuli			Newly composed stimuli		
	B	*SE B*	*β*	*B*	*SE B*	*β*
Step 1						
Constant	-.019	.055		-.137	.058	
Perceived valence	.736	.025	.738***	.735	.029	.691***
Step 2						
Constant	-.021	.055		-.106	.059	
Perceived valence	.735	.025	.738***	.731	.029	.688***
Perceived arousal	-.025	.024	-.027	-.065	.026	-.067*

Note: R^2 = .545 for Step 1, ΔR^2 < .001 for Step 2 (p = .287) for standardized stimuli. R^2 = .478 for Step 1, ΔR^2 = .004 for Step 2 (p = .014) for newly composed stimuli.

* p < .05, *** p < .001

Table 14. Experienced arousal is predicted by perceived arousal and not perceived valence.

	Standardized stimuli			Newly composed stimuli		
	B	*SE B*	*β*	*B*	*SE B*	*β*
Step 1						
Constant	-.153	.051		.009	.053	
Perceived valence	.728	.022	.778***	.681	.024	.731***
Step 2						
Constant	-.146	.052		.020	.053	
Perceived valence	.727	.022	.777***	.679	.024	.729***
Perceived arousal	-.025	.023	-.025	-.041	.026	-.040

Note: R^2 = .605 for Step 1, ΔR^2 = .001 for Step 2 (p = .288) for standardized stimuli. R^2 = .534 for Step 1, ΔR^2 = .002 for Step 2 (p = .119) for newly composed stimuli.
* $p < .05$, *** $p < .001$

Per-participant standardized regression coefficients were calculated for the experience of an emotion component as predicted by the perception of the component, and for each of the stimulus types. This yielded four new variables, each assessing the degree of change in experience as related to observed change in perception. These data were merged backed into a single file and submitted to a repeated-measures MANOVA, with group as a between-subjects factor and stimulus type as a within-subjects factor for the two measures, valence association and arousal association. Box's *M* = 18.289 was associated with a non-significant p = .069 and equal covariance matrices between groups were assumed. Multivariate tests found no significant main effect of group on the combined associations (p = .421, $\eta 2$ = .023). Similarly, the main effect of stimulus type (p = .162, $\eta 2$ = .047) and the stimulus type x group interaction effect (p = .409, $\eta 2$ = .023) were non-significant.

On average, patient perceptions and experiences were as strongly associated (M_r = .759, *SE* = .032) as control perceptions and experiences (M_r = .752, *SE* = .026). As Figure 6 illustrates, patients tended to be less affected by stimulus type and tended to exhibit a larger dissociation between perceived and experienced valence and a smaller dissociation between perceived and experienced arousal. However, within-subjects analysis reiterated that these tendencies were non-significant. The main effects of stimulus type on the valence association (p = .196, $\eta 2$ = .022) and the arousal association (p = .136, $\eta 2$ = .029) as well as the type x group interaction effect on both (p = .422, $\eta 2$ = .008; p = .262, $\eta 2$ = .016, respectively) were not significant. The main effect of group on the valence association (p = .550, $\eta 2$ = .005) or the arousal association (p = .381, $\eta 2$ = .010) was neither significant. Levene's test indicated that the homogeneity of variance assumption might have been violated for the valence association between pairs of standardized stimuli, $F(1, 77) = 5.835$, p = .028, but this was unsupported using Hartley's variance ratio, which did not surpass its critical value (F_{Max} = 1.95).

Since no significant group variations by stimulus component or stimulus type were observed, a grand average association was calculated for the purposes of subgroup analysis. With equal variances assumed, the one-way ANOVA indicated that neither subgroup differed from the other in the overall strength of the association between the perception and the experience of musical emotion (p = .823, η^2 = .010).

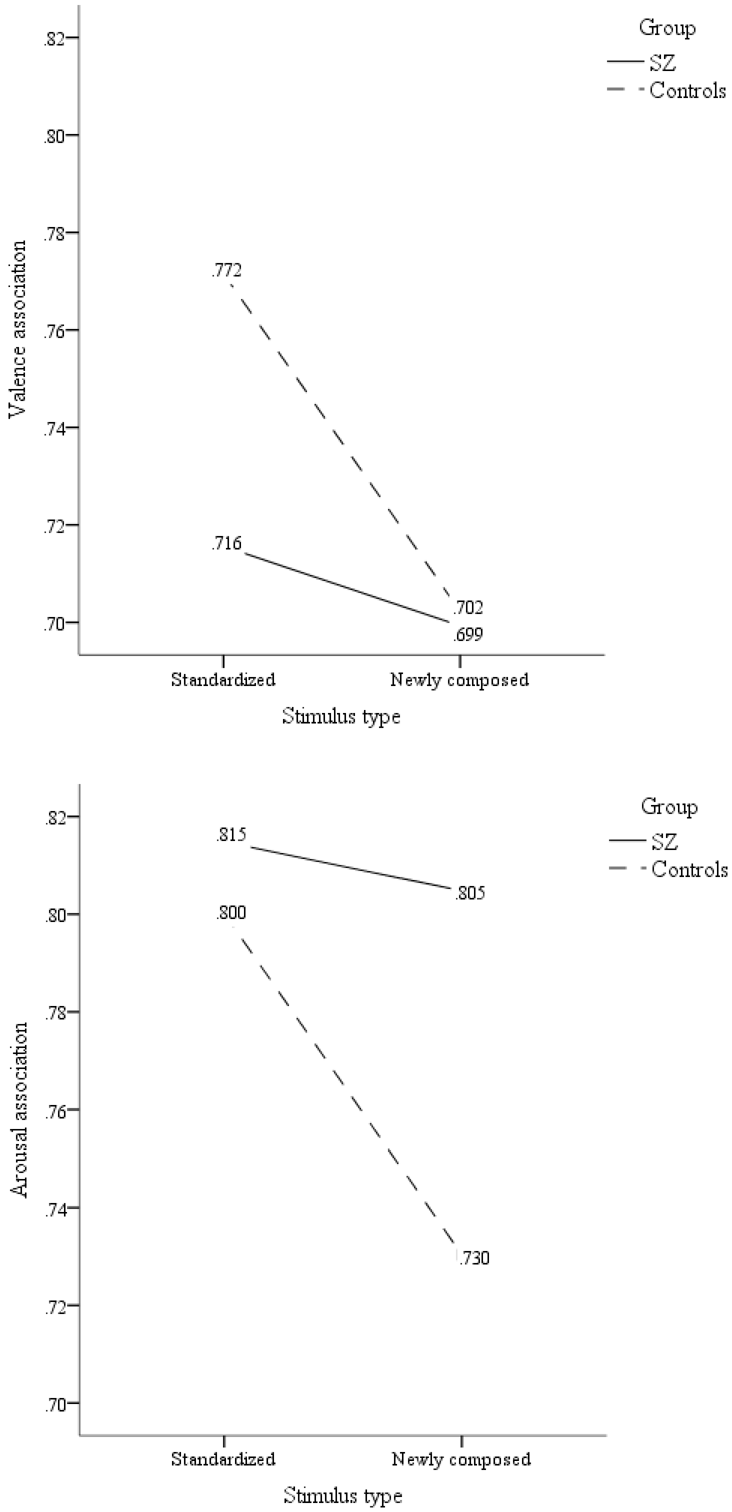


Figure 6. Person with schizophrenia exhibited a strong association between the perception and the experience of musical emotion.

4.1.5. Emotion Intensity and Symptomatology

In order to investigate possible group differences in the intensity of emotion (rather than the extent to which it is considered just negative or just positive), the absolute value of each rating obtained was determined. These values were then averaged into four new variables (equation 2), each assessing the intensity of musical arousal or valence for the standardized or newly composed stimuli. Preliminary correlational analysis suggested a significant relationship between overall intensity and MES-I in the SZ group, r = -.327, p = .039.

$$\text{Intensity per emotion component x stimulus type} = \frac{(\,|\text{stimulus 1 perception}| \ldots |\text{stimulus n perception}|) + (\,|\text{stimulus 1 experience}| \ldots |\text{stimulus n experience}|)}{2\text{n}} \quad (2)$$

A repeated-measures MANCOVA was conducted for the measures of valence intensity and arousal intensity, with group as a between-subjects factor, stimulus type as a within-subjects factor, and the MES-I score as a covariate. Box's test returned an M-value of 9.066, and a non-significant p-value of .575. The main effect of group on emotion intensity was significant, V = .019, $F(2, 75)$ = 3.471, p = .036, η^2 = .085, as was the type x group interaction effect, V = .176, $F(2, 75)$ = 7.995, p = .001, η^2 = .176. The effects of the MES-I score (p = .492), stimulus type (p = .062), or their interactions (p = .466) were non-significant.

Figure 7 shows that patient emotions (overall M = 1.975, SD = .407) were more intense than control emotions (overall M = 1.763, SD = .357). Within-subjects analysis found this to be the case for both emotion components, showing a significant main effect of group on valence intensity, $F(1, 76)$ = 4.304, p = .041, η^2 = .054, and arousal intensity, $F(1, 76) = 5.905$, $p = .017$, $\eta^2 = .072$. The assumption of homoscedasticity was met for each variable.

As apparent from Figure 7a, controls but not patients were affected by stimulus type, as their emotion intensity decreased for the newly composed stimuli. This effect was significant for both valence intensity, $F(1, 76) = 4.304$, $p = .041$, $\eta^2 = .054$, and arousal intensity, $F(1, 76) = 5.905$, $p = .017$, $\eta^2 = .072$.

Figure 7b also suggests that the main effect of group or the group x stimulus type interaction effect remained unaffected by stimulus valence or stimulus arousal. Since these variables could not be entered into the statistical model, the exact probabilities of their effect or lack thereof were neither determined.

A removal of the MES-I covariate from the statistical model rendered the main effect of group on valence intensity non-significant ($p = .076$). Split-group multiple regression analysis was thus conducted to parse the association between MES-I and overall valence intensity. With MES-I entered in step 1, CAPE-42 scores were controlled for in step 2, owing to the previously observed relationship between those and MES-I (4.1.2). No significant associations surfaced in the control group. In the SZ group, MES-I alone did not significantly predict the mean intensity of musical valences ($p = .068$). Entering CAPE-42 scores into the model did not improve the overall fit of the model ($p = .086$) but increased the predictive value of MES-I, $B = -.041$, $SE = .018$, $\beta = -.373$, $p = .025$. The finding indicates that patients who used music for self-regulation more often tended to perceive and experience musical valences of lesser intensity.

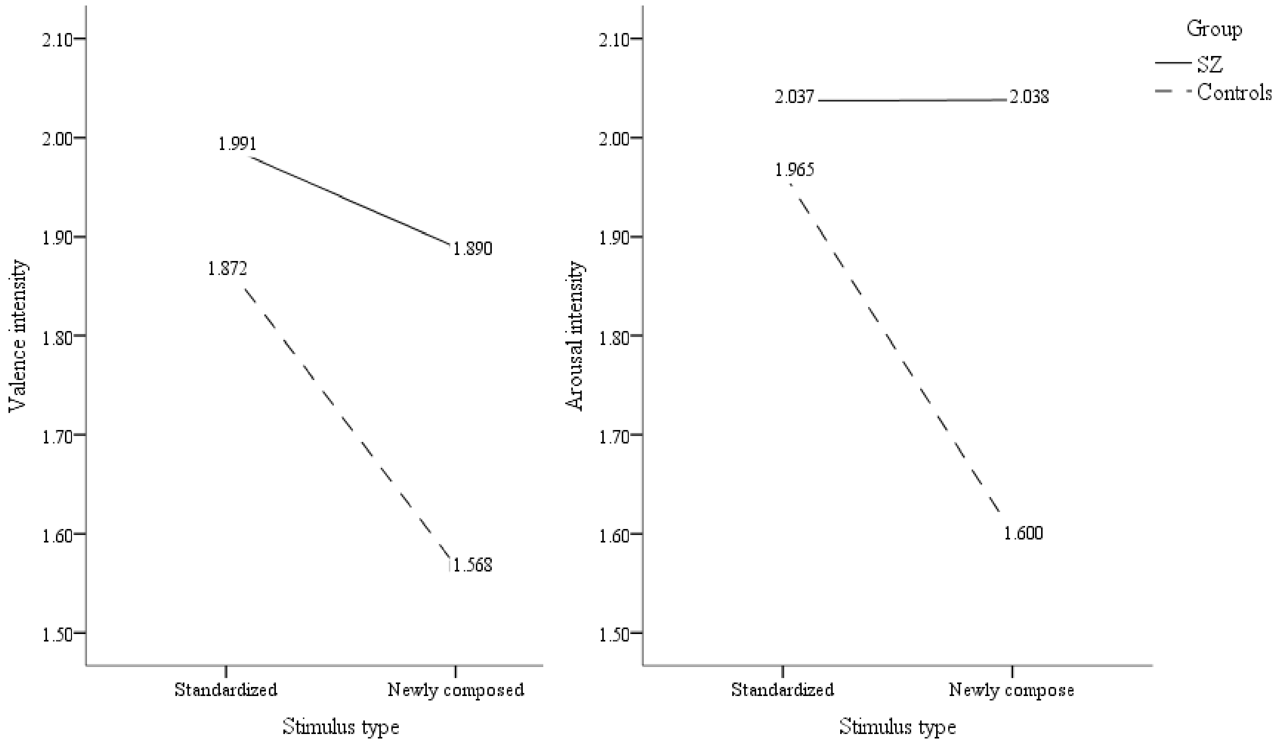
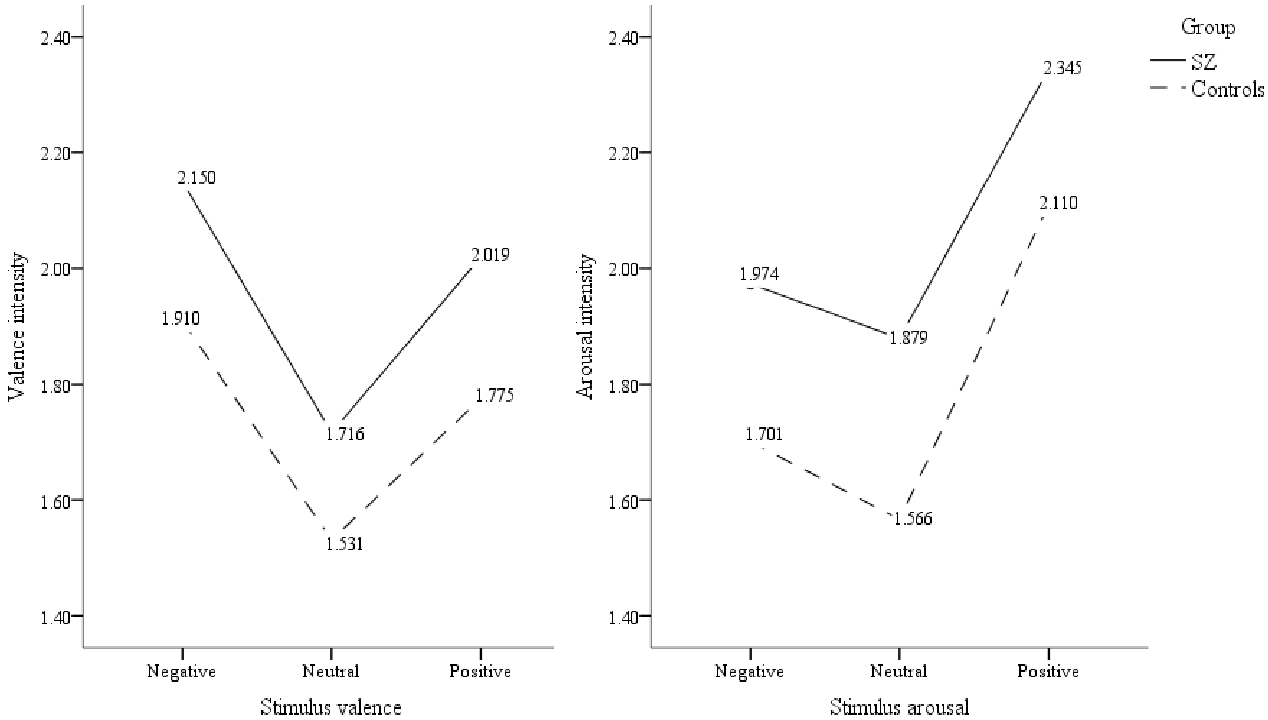


Figure 7a. Control emotion intensity appeared to be more affected by stimulus type. Covariates evaluated at MES-I = 19.114.

7b. Patient emotions were consistently more intense.



Finally, subgroup differences in overall intensity associated with standardized and with newly composed stimuli were probed by means of a MANOVA. Homogenous covariances (Box's $M = 3.583$, $p = .777$) and variances were assumed. The overall effect of subgroup on emotion intensity, irrespective of stimulus type, was not significant ($p = .129$). The effect of subgroup on emotion intensity associated with the newly composed stimuli was statistically significant, $F(2, 37) = 3.584$, $p = .038$, $\eta^2 = .162$. Figure 8 portrays this relationship: simple effects specified that both the PS and the NS subgroups recorded higher emotion intensity than the acute psychosis subgroup ($p = .020$, $p = .028$, respectively). Figure 8 shows that a similar tendency applied to the standardized stimuli, but this tendency failed significance ($p = .332$).

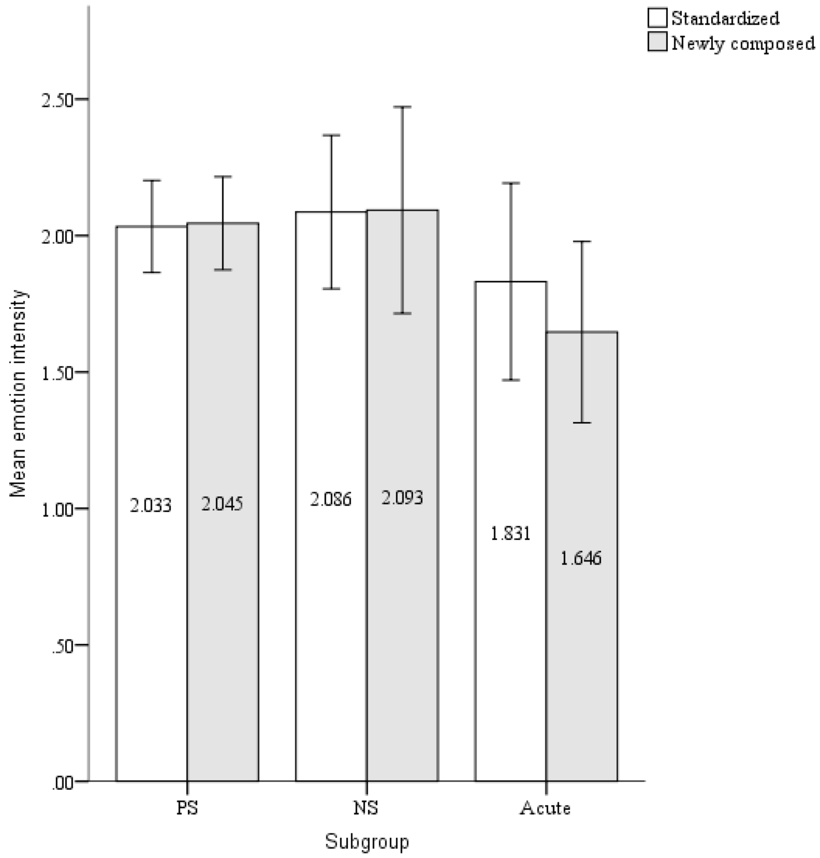


Figure 8. Mean intensity of emotion evoked by standardized and newly composed stimuli in the PS, NS, and acute psychosis subgroup. The latter recorded less emotion for newly composed stimuli.

4.2. Study 2; Emotional Stroop Performance

4.2.1. Data Distribution

Six members of the patient group were exempt from completing the task due to gross cognitive impairment or illiteracy. Further three patients and four controls were excluded from analysis since their accuracy was markedly lower than their group's mean, suggesting they misunderstood the task or procedure. These outlying values were identified using Tukey's hinges (Q3 + 1.5 IQR) and steam-leaf plots and corresponded with more than 316 mistakes in the patient group and more than 61 mistakes in the control group.

In total, 40 controls and 35 patients (16 PS, 11 NS, 8 acute) completed the task as per the guidelines and proceeded to the analysis stage. No significant differences in demographic variables surfaced between the two groups (age p = .383, gender p = .826, years of education p = .562) or the three subgroups (age p = .714, gender p = .190, years of education p = .751).

4.2.2. Errors

Controls made less errors (M = 14.90, SD = 10.97, range = 1 - 43) than the SZ group (M = 76.46, SD = 67.97, range = 7 - 237) and this difference was significant, $t(35.6) = 5.298$, $p < .001$. Within the SZ group, the PS subgroup (M = 80.13, SD = 77.74, range = 8 - 237), the NS subgroup (M = 65.18, SD = 57.36, range = 8 - 206), and the acute psychosis subgroup (M = 84.63, SD = 66.94, range = 7 - 215) did not significantly differ in the number of errors made (p = .802). Error-trials are not considered in any of the further analyses.

4.2.3. Response Times

Table 15 lists raw mean reaction times and standard deviations per the two groups and three subgroups, and per word and valence categories. As expected, the SZ group recorded longer RTs and larger variances, and preliminary Levene's test indicated that between-group variances were unequal for all word and valence categories. To account for this, all analysis derived from D-transformed variables (equation 1), which reflected interference (positive values) or sensitization (negative values) towards negative control, PS-related, or NS-related words (Table 15).

Table 15. Mean reaction times by group and subgroup.

		Control words			PS-related words			NS-related words		
		Neu	Neg	D-SI	Neu	Neg	D-SI	Neu	Neg	D-SI
Group		*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	M ± *SD*
Control		673.97 ± 59.99	675.40 ± 57.28	.006 ± .204	675.62 ± 60.07	676.27 ± 58.94	.000 ± .159	677.55 ± 58.10	677.63 ± 58.55	- .006 ± .175
SZ		745.38 ± 96.17	747.77 ± 94.68	.015 ± .274	740.17 ± 97.57	752.44 ± 93.34	.097 ± .247	744.20 ± 102.16	751.80 ± 97.22	.058 ± .336
	PS	751.95 ± 110.36	751.57 ± 107.22	- .019 ± .327	740.77 ± 114.81	763.67 ± 106.54	.190 ± .283	741.54 ± 124.32	767.33 ± 115.45	.199 ± .396
	NS	747.60 ± 73.97	748.02 ± 71.11	.006 ± .254	737.83 ± 72.75	752.85 ± 66.93	.128 ± .149	755.57 ± 74.44	736.24 ± 70.64	- .158 ± .244
	Acute	729.16 ± 102.95	739.84 ± 107.59	.096 ± .182	742.21 ± 102.08	729.41 ± 103.73	- .130 ± .112	733.91 ± 96.52	742.14 ± 95.80	.070 ± .095

A repeated-measures ANCOVA first compared the effects of group membership and word category on D-SIs, whilst controlling for CAPE-42 scores. The main effect of group failed significance (p = .451), meaning that patient and control D-SIs did not significantly differ when other variables were not concerned.

Mauchly's test of sphericity suggested that no correction needed to be applied to the following results. Neither symptom-relatedness (p = .090) or the symptom-relatedness x group interaction (p = .925) affected D-SIs. The interaction effect of symptom-relatedness and CAPE-42 scores was near significant, $F(2, 144) = 2.982$, $p = .054$, $\eta 2 = .040$. Simple contrasts suggested that CAPE-42 scores accounted to a significant difference in PS-related compared to control D-SIs, $F(1, 72) = 5.684$, $p = .020$, $\eta 2 = .073$, but not in NS-related compared to control D-SIs (p = .347). While a diagnosis of a schizophrenia spectrum disorder did not affect D-SIs differently to no diagnosis, variations in CAPE-42 appeared to. This suggested that the SZ group was not homogenous, and variations within it could better explain the data observed.

A separate repeated-measures ANOVA was next conducted to compare the effects of subgroup membership (PS, NS, and acute subgroup) and symptom-relatedness on D-SIs. Homoscedasticity was assumed as per Levene's tests and Hartley's variance ratios. The assumption of sphericity was neither violated.

The main effects of subgroup (p = .226) and symptom-relatedness (p = .791) failed significance, meaning that neither variable alone affected D-SIs. The interaction effect between symptom-relatedness and subgroup was statistically significant, $F(4, 64) = 5.901$, $p < .001$, $\eta^2 = .269$. Simple contrasts disclosed a significant subgroup difference in the D-SIs of PS-related compared to control words, $F(2, 32) = 4.507$, $p = .019$, $\eta^2 = .220$, as well as the D-SIs of NS-related compared to control words, F(2,

32) = 4.975, p = .013, η^2 = .237. Figure 9 suggests that: 1) the PS subgroup exhibited the most symptom-related interference, 2) the NS subgroup exhibited NS-related facilitation and PS-related interference, and 3) the acute psychosis subgroup showed signs of PS-related facilitation.

A series of “protected” one-way ANOVAs with Tukey HSD tests were conducted to determine the statistical significance of subgroup differences in each D-SI. Post-hoc tests revealed that the acute psychosis subgroup had significantly lower PS-related D-SIs than both the PS (p = .005) and the NS subgroup (p = .041). The level of PS-related interference did not significantly differ between the PS and the NS subgroup (p = .744). NS-related D-SIs were significantly lower in the NS subgroup compared to the PS subgroup (p = .015) but not compared to the acute subgroup (p = .260). NS-related interference also did not differ between the PS and the acute subgroup (p = .599). As for control D-SIs, no statistically significant subgroup differences emerged.

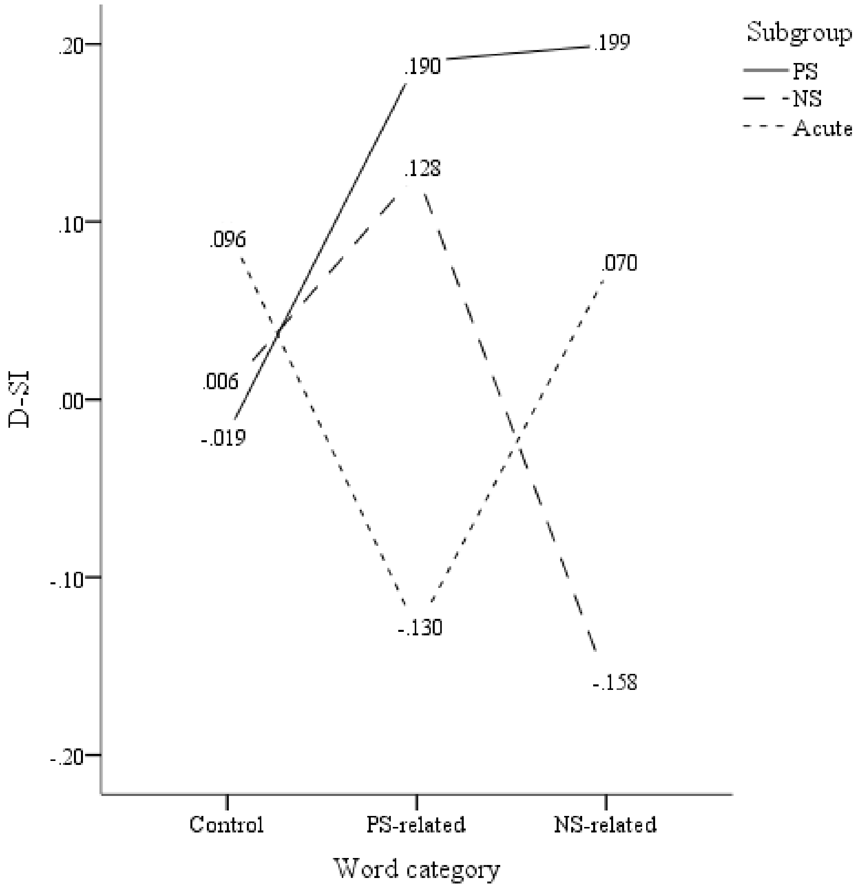


Figure 9. Persons with paranoid and positive symptomatology exhibited the strongest symptom-related interference. Negative symptomatology appeared to foster reactivity to negative-symptom words, while acute psychosis related to increased reactivity to positive-symptom words.

5. Chapter 5: Discussion

5.1. The Emotion-Paradox in Schizophrenia

Multiple meta-analyses of over a hundred studies found that schizophrenia relates to a pronounced impairment in the recognition, identification, or discrimination of facial and prosodic emotions (Aleman & Kahn, 2005; Phillips & Seidman, 2008; Trémeau, 2006). This impairment is included under the term flattening, which also describes the reduced strength and frequency with which persons with schizophrenia express an emotion. Yet, persons with schizophrenia do not show a similar level of impairment when they are experiencing an emotion, be it induced by videos and recordings of faces and speech, or by stimuli as diverse as smells, tastes, and activities can be (Aleman & Kahn, 2005; Cohen & Minor, 2008; Trémeau, 2006). Experiences may, in fact, intensify, i.e. increase in strength and frequency, often in response to psychotic symptoms or their connotations in the outside world (Aleman & Kahn, 2005; Krabbendam & Van Os, 2005).

This split - between the appearance of an impaired percept in the face of a preserved experience - is the emotion-paradox in schizophrenia, and the subject of this thesis. Most posit that the emotion-paradox stems from a generalized emotion perception impairment (Edwards et al., 2002; Schneider et al., 2006; Shayegan & Stahl, 2005), but critics argue for an alternative explanation. This thesis aimed to assess two of the most common alternatives.

One alternative interpretation of the emotion-paradox in schizophrenia proposes that the incongruency, which the phenomenon describes, results from the incongruent method and material, which emotion perception and emotion experience studies employ. This view suggests that the perception of an emotion burdened by lighter socio-cognitive demands would not dissociate from the experience of this emotion (Darke et al., 2013; Rossell & Boundy, 2005). The second interpretation of the emotion-paradox concurs and adds that incongruent measurement methods and short-sighted assumptions may be at fault also. This view suggests that the true emotion-paradox in schizophrenia describes a split between explicit emotion labelling and implicit feeling, rather than between the appraisal of external and internal emotional states (Mano & Brown, 2012; van 't Wout et al., 2007).

In the case of the first interpretation, findings of Study 1 raised support for the view that methodological restrictions skewed observations of the emotion-paradox in schizophrenia. In this study, participants with and without schizophrenia reported the arousal and valence that they perceived and experienced in response to musical stimuli. No evidence of an emotion perception impairment was observed: persons with schizophrenia provided accurate ratings of the valence and arousal of all combinations of negative to positive, and calming to arousing music. This finding contradicts the staple interpretation of the emotion-paradox in schizophrenia (Edwards et al., 2002; Schneider et al., 2006; Shayegan & Stahl, 2005), showing that it may not be considered in light of a generalized emotion perception impairment. Moreover, the perception of a component predicted the experience thereof as strongly in healthy controls as it did in the patient group. Within the patient group, all with acute psychosis and positive or negative symptomatology demonstrated this association to the same degree. This finding casts doubt on the sole existence of the emotion-paradox in schizophrenia, showing that in some conditions, the perception and experience of emotion need not dissociate.

Further analysis supported the validity of these findings, showing that all non-significant main or interaction effects of group coincided with an effect size far below the conventional threshold of interest (Cohen, 1988). While a minimal effect size cannot exclude the possibility of Type II error, it can specify that any potentially overlooked group differences in the perception and experience of a musical emotion would lack a practical impact.

Furthermore, the findings occurred despite the choice of methodology which can exhibit superior sensitivity to perception-experience dissociations. Music psychology specializes in this dissociation and recommends many tested methods of study (Gabrielsson, 2002; Schubert, 2013). Possibly most important is the simultaneous assessment of the perception and experience of musical emotion, a method of distinct sensitivity to the differences between them (Schubert, 2013). Study 1 followed this recommendation, being the first to do so in the context of schizophrenia research. Standardized material should also be preferred in order to protect the external validity of the results (Eerola & Vuoskoski, 2013). Accordingly, Study 1 sourced a well-established battery of emotional music (Eerola & Vuoskoski, 2011), similar to the popular series of Pictures of Facial Affect (Ekman & Friesen, 1976). All stimuli chosen or composed were unfamiliar and instrumental, to minimize the potentially confounding effects that memory and voice can exert on a musical emotion (Juslin & Västfjäll, 2008). Finally, participants were matched on their background in music, an often ignored yet potentially powerful confound (Abe et al., 2016). All in all, Study 1 found considerable support for the absence of a perception-experience dissociation, as the first interpretation of the emotion-paradox in schizophrenia predicts. Nonetheless, the study did not exclude the applicability of another, more extended explanation.

The second interpretation of the emotion-paradox in schizophrenia highlights that typical emotion perception tasks require full awareness and appraisal of stimuli, thus their explicit labelling. Schizophrenia may diminish the individual's ability to appraise and name, thus their explicit emotion processing (Mano & Brown, 2012; Roux et al., 2010). In contrast, emotion experience studies utilize a wealth of less explicit methods, including socio-cognitively undemanding material or the self-report of experienced valence and arousal (Aleman & Kahn, 2005). Emotion experience studies thus often measure the implicit experience, which appears preserved and at times heightened in schizophrenia (Mano & Brown, 2012).

In their wider context, findings of Study 1 can accommodate this second interpretation. Past research on musical emotion in schizophrenia described their recognition as significantly or near-significantly impaired (Table 2). In contrast, Study 1 showed that individuals with and without schizophrenia recognized musical emotions with matching proficiency. A disparity in the method of measurement is the likeliest root of this conflicting finding. Past research on the perception of musical emotion measured discrete emotions (Table 1), which require explicit processing (Mano & Brown, 2012). Study 1 measured dimensional emotions, which make do with implicit processing (van 't Wout et al., 2007). Therefore, the findings of Study 1 may only extend to implicit musical emotion, reflecting the maintenance (or intensification, as discussed in 5.2.) of those only.

Accordingly, Study 2 documented the maintenance and heightening of implicit emotion in schizophrenia, as the second interpretation predicts. In this study, controls and schizophrenia patients with acute, positive, or negative symptomatology completed an emotional Stroop task (EST), in which they identified the colour of neutral and negative words connoting either positive, negative, or no symptoms of schizophrenia. The participants displayed comparable interference to negative compared to neutral words, irrespective of the symptom-relatedness of these words. This finding shows the preservation of implicit emotion in persons with schizophrenia. Patient subgroups recorded a distinct pattern of interference and facilitation towards negative content related to their concern. This finding demonstrates the heightening of implicit emotion in the population.

Several methodologic and statistical choices supported the validity of these results. Of great importance was the use of a newly developed EST – which allowed for a meaningful comparison of the effects of stimulus valence and symptom-relatedness – and the D-transformation procedure (Greenwald et al., 2003) – which minimized the impact of the gross RT variations within the patient group. Study 2 used short but manageable response windows to maximize the applicability of its results to implicit emotion processing, and a randomized stimulus presentation coupled with a varied inter-trial-interval to circumvent response habituation. Stimuli were carefully selected and matched on key confounding variables such as their length. The number of stimuli and the size of the sample were large compared to other studies in the field (Table 4).

Taken together, results of Study 1 and Study 2 concurred that methodological restrictions skewed the understanding of the emotion-paradox, which does not arise from a generalized emotion perception impairment, and which instead reflects a split between the explicit and the implicit processing of emotion. This thesis recommends the second interpretation of the emotion-paradox in schizophrenia for use and further study.

The results of this thesis chiefly support the broader knowledge and improved understanding of a research problem, which might, in turn, have implications for clinical practice. Music therapy interventions draw on the assumption of a close correspondence between emotion perception and experience (Gabrielsson, 2002). Fortunately, this assumption does not appear to be violated in the case of schizophrenia, as the more widely accepted interpretation of the emotion-paradox would suggest. The observed maintenance and heightening of lower-order emotions could be a valuable therapeutic tool. Assuming that these characteristics can transfer onto other areas, they could aid in the amelioration of explicit emotion flattening. Indeed, music therapy seems to be effective at this venture (Silverman, 2003).

Future research on the emotion-paradox in schizophrenia should take note of some of the limitations of the present research. One limitation may be the lack of a direct comparison measure of explicit emotion processing. This thesis prioritized the inspection of the commonly neglected lower-order emotion and supposed that the addition of another comparison measure would needlessly complicate the procedure. In fact, the applied design alone proved demanding. Study 1 was particularly guilty of this, confusing many listeners despite the spoken, written, and pictorial instructions accompanying it. In this case, replication studies may opt for separate axes for the assessment of all perceived and experienced valences and arousals; a similarly adjusted design might be more comprehensible, but might also increase the time demands of the task and thus non-compliance with the task. Study 2 was also challenging for some, all by the nature of its substantial stimulus pool. Future studies which wish to add an explicit emotion comparison measure should also adjust the overall study design, and either arrange multiple testing sessions, or settle for a split-group design. However, given the extensive research on explicit emotion in schizophrenia, and the consistent evidence of impairments that it offers (Aleman & Kahn, 2005; Phillips & Seidman, 2008; Trémeau, 2006), these adjustments may be of more risk than benefit.

Instead, future research should aim to determine the point of the split which the emotion-paradox describes. In the context of Study 1, a simultaneous study of dimensional and discrete emotion perception may be of benefit, helping to deduce more precise bounds of the implicit and the explicit. In the context of Study 2, manipulating the response window along with the inter-trial-interval could be of similar value.

Other than improved or specified, present findings can also be supplemented. One means of extending the findings of Study 1 include the use of participant-selected stimuli. On the one hand, data gathered from participants who all perceived and experienced a different stimulus necessitate a qualitative approach, which was out of the present scope. On the other hand, participant-selected music may show a greater perception-experience dissociation (Schubert, 2013), which could present an attractive objective for other researchers. Study 2 could benefit from the addition of a neurologic method of measurement. EEG and particularly ERP measures could help trace the time-lime at which the emotion-paradox develops. While expensive, imaging the EST performance of persons with schizophrenia could also improve the understanding of the mechanisms which underlie it.

5.2. Musical Emotions in Schizophrenia

Musical emotions are not mere subjective phenomena, too loosely defined to be studied scientifically – they can have experimental utility and practical applications (Vieillard et al., 2008). Indeed, music has a history of unexpected effects on psychopathologies, having helped to identify both underlying trends missing for a complete theory of emotion, as well as interactions specific to the stimulus or disorder (Lima, Garrett, & Castro, 2013; Quintin et al., 2011). As such, music was particularly well-suited for the investigation of the emotion-paradox in schizophrenia, as well as other, no-less-intriguing aspects of schizophrenic emotion. The below discussion centres on the most important, or unexpected of these.

Persons with and without schizophrenia appear to perceive and experience musical valences similarly (2.1.2.), which Study 1 corroborated. But it has also been suggested that persons with schizophrenia perceive and experience higher musical arousal (2.1.2.) and Study 1 uncovered no such effects. Instead, schizophrenia patients perceived and experienced all calming, neutral, and energizing music with as much arousal as healthy controls did. The unexpected finding may be due to conceptual differences. One emotion perception study, which suggested that musical arousal heightened in schizophrenia, relied on the discrete model of emotion, meaning that arousal was not actually analysed (Weisgerber et al., 2015). A plethora of music experience studies found evidence for overarousal in psychophysiological (Akar et al., 2015; Akdemir et al., 2010), spectral EEG (Burge & Siebert, 2010; Günther et al., 1993, 1991), and BOLD readings (Dyck et al., 2014). One of these studies - which included a simultaneous self-report measure - found that neurophysiological overarousal did not correspond with reported overarousal (Burge & Siebert, 2010). It may be that self-report is less sensitive to the overarousal effect; thus, Study 1 was unable to capture it. Alternatively, it may be that neurophysiological overarousal reflects 'more' arousal, rather than its raw increase.

The amount of an emotion is referred to as its intensity, which - in the dimensional model of emotion - reflects the distance-to neutral irrespective of direction. This variable showed a statistically significant increase amongst patients with schizophrenia. Relative to healthy controls, patients perceived and experienced more of both arousal and valence. The between-group difference in arousal intensity reached a higher effect size and showed fair robustness despite changes to the statistical model. The increase in valence intensity was only significant with MES-I scores controlled.

The MES-I measures the extent to which listeners use music for cognitive and emotional regulation (Chin & Rickard, 2012). The more often patients used music to this end, the less valence they perceived and experienced. Controls demonstrated no such association. In schizophrenia, the frequency of musical self-regulation relates to an improved ability to regulate musical valence. Further research should look into the possibility of a causal relationship.

Schizophrenia patients perceived and experienced more arousal with all combination of stimulus valences and arousals. This finding suggests some reduction in patient ability to regulate musical arousal, thus corroborating previous musical (Dyck et al., 2014; Weisgerber et al., 2015) and nonmusical research (Cohen & Minor, 2008). The reduced capacity of persons with schizophrenia to regulate emotion is thought to result from the inefficient bottom-up processing of this emotion. Imagining (Dyck et al., 2014) and EEG (O'Donnell et al., 2012) evidence can concisely illustrate this process, showing reduced filtering and organization of sensory information, followed by top-down activity unable to counteract this overload. In the specific context of music, further processing idiosyncrasies may contribute to the failed regulation of emotion. In healthy subjects, a high intensity of musical emotion may correspond to dopamine release (Chanda & Levitin, 2013). The excess and overactivation of dopamine receptors in the mesolimbic pathway can cause schizophrenia and the positive symptoms that it can produce (Davis et al., 1991; Howes & Kapur, 2009). Two equally likely possibilities exist at present: that the baseline hyperactivity of dopaminergic projections causes or contributes to the increased intensity of musical emotions in schizophrenia, or that the increased intensity of musical emotions fosters an additional, unwelcome release of dopamine. Future research can benefit from tracing the direction of this relationship between neurological excess and behavioural increase. Imagining music-related subcortical activation would offer the most precise results but - given the challenges associated with this method - should only be undertaken once behavioural evidence is more complete. Qualitative or experience sampling methods could be of benefit in this respect.

Musical emotions are thought to be unaffected by schizophrenic symptomatology (Burge & Siebert, 2010; Feingold et al., 2016; Weisgerber et al., 2015), a conclusion Study 1 substantiated. Patients with acute psychosis as well as positive or negative symptomatology demonstrated similar patterns of valence and arousal recognition and comparable increases in valence and arousal intensity. Apparently, the maintenance and intensification of lower-order musical emotion represent a trait, not a state of the schizophrenia spectrum.

Study 1 also sought to explore the impact of musical symptom-relatedness on schizophrenic musical emotions. Short pieces of instrumental music were newly composed to reflect the symptoms of schizophrenia which occur in various states of the disorder. The newly composed stimuli were of similar valences and arousals as the standardized stimuli, and of far greater levels of dissonance and distortion.

Interestingly, patients with schizophrenia tended to perform with greater accuracy than healthy controls, being more likely to report the valence and arousal that each newly composed excerpt aimed to express. A closer inspection of the result revealed some flattening of control percepts; controls tended to assign moderate arousal and neutral valence to all newly composed stimuli. Controls also recorded significantly lower levels of intensity for all perceived and experienced valences and arousals.

This seemingly improved ability of schizophrenia patients to recognize and experience symptom-related music may, in fact, stem from their reduced ability to hear the music. Indeed, persons with schizophrenia may be less able to perceive some characteristics of music (Hatada et al., 2014), thus also the distortions of those characteristics. Accordingly, past research on musical emotion in schizophrenia uncovered evidence of reduced sensitivity to dissonance (Nielzén & Cesarec, 1982; Nielzén et al., 1993), stimulus degradation (Burge & Siebert, 2010), and even noise (Akar et al., 2015; Akdemir et al., 2010). Unfortunately, past studies failed to examine the auditory ability of their participants, and Study 1 shared this critical shortcoming. All participants reported normal hearing yet – given the high rates of schizophrenia-related amusia (Hatada et al., 2014) – may have suffered from small deficits in pitch and melody perception. Replication studies must take this possibility into account.

Fortunately, compromised hearing was unlikely to act alone. Further analysis specified that the improved accuracy and intensity of musical emotions pertained to two subgroups only: patients with positive schizophrenia and schizoaffective disorder, and patients with negative schizophrenia and schizoaffective disorder. Persons with an acute psychosis did not demonstrate the effect and instead submitted perception and experience ratings on par with controls. Auditory deficits are considered a trait-, not state-characteristic, having been observed throughout the most extended schizophrenia spectrum (O'Donnell et al., 2012). Thus, auditory deficits cannot explain these differences between subgroups.

Another explanation, first put forth elsewhere (Nielzén & Cesarec, 1982; Nielzén et al., 1993), suggests that persons who have more experience with perceptual alterations may also have more experience with solving those alterations. In this view, experienced patients learn to disregard the complexity, dissonance or degradation of sound, which improves their ability to process other characteristics of the sound. Accordingly, the acute psychosis subgroup in Study 1 included some of the least experienced patients: a diagnosis of an acute psychotic disorder necessitates that the symptoms of the disorder last less than a month, and is rarely received by individuals with an existing diagnosis of a more serious psychotic disorder (World Health Organization, 1992). However, this is a mostly speculative, albeit attractive explanation. Still, the exploratory part of Study 1 brings one encouraging implication, showing that patients with schizophrenia demonstrate no stress reaction to music – including music which was composed to elicit one.

5.3. Emotional Stroop Performance in Schizophrenia

The EST represents a behavioural measure of implicit emotion reactivity. With novel design applied to this task, Study 2 delivered the first demonstration of some of the specific conditions in which implicit emotion processing is preserved, and in which it heightens in schizophrenia. As such, the study yields implications which go beyond the matter of the emotion-paradox and which could suggest avenues for the treatment and management of the disorder.

The implicit processing of negative valences was unaffected by the diagnosis of schizophrenia. Persons with and without schizophrenia displayed comparable interference to negative compared to neutral words, irrespective of their symptomatology or the symptom-relatedness of the words. Past studies observed a similar effect, documenting preserved processing of implicit negative emotion in faces (van ’t Wout et al., 2007), prosody (Roux et al., 2010), and words (Demily et al., 2009). This supports the idea that persons with schizophrenia maintain the ability to process implicit emotion (Mano & Brown, 2012), as long as this emotion is of generally negative valence.

Implicit processing of negative content related to the respondent’s concern appeared to heighten, meaning it interfered or facilitated EST performance. Individuals with positive schizophrenia and schizoaffective disorder displayed interference towards PS-related and NS-related emotion. Interference was previously observed in persons with paranoid symptoms exposed to implicit connotations of these symptoms (Bentall & Kaney, 1989; Besnier et al., 2011; Fear & Healy, 1996; Fear et al., 1996; Kinderman et al., 2003). The present finding matches and furthers these observations, suggesting that interference in this population may generalize to any disorder-related emotion.

Persons with acute psychosis – who were experiencing schizophrenia-like symptoms for less than a month - displayed no significant NS-related changes, which may be due in part to the limited experience they had with negative symptoms. Controlling for previous hospitalizations may prove fruitful in this respect. Acute psychosis patients also showed signs of PS-related facilitation. Short PS-related latencies were previously observed in first-episode psychosis patients with a low level of insight (Wiffen et al., 2014). Low insight fosters the avoidance of self-related information (Wiffen et al., 2014), and avoidance can underlie facilitation. While the present subgroup reported distinctly low CAPE scores, which may suggest impaired insight, future studies should add a direct measure of the variable.

Individuals with negative schizophrenia and schizoaffective disorder showed PS-related interference and NS-related facilitation. Negative symptomatology received little attention in past EST studies, and this was the first demonstration of symptom-related changes in this population. Assuming their replication, the findings support the above suggestion, that affect-laden descriptors of symptoms promote reactivity in persons with experience with these symptoms. Assuming that facilitation relates to avoidance, NS-related facilitation could also relate to the explicit emotion impairments and flat affect that can accompany negative symptomatology (Mano & Brown, 2012). The finding also highlights how flat affect, a common component of negative schizophrenia, need not characterise internal processes.

These findings were likely unmediated by hidden variations in cognitive ability. All subgroups demonstrated comparable error rates, suggesting that whichever cognitive deficits may have affected their EST performance did not differ between them - furthermore, statistical analysis derived from D-transformed measures. The adjusted design of the task accommodated both neutral and negatively valenced descriptors of symptoms, thus enabling a clear interpretation of their comparison. Overall, the conclusion that persons with schizophrenia maintain the ability to process negative valence, but show increased reactivity to symptom-related emotion, appears valid.

Past research also suggested that implicit processing of emotion could heighten in schizophrenia (Mano & Brown, 2012) but this study was the first to specify the conditions which promote the process. Crucially, increased explicit emotion reactivity to symptoms and their connotations can relate to a worse prognosis (Krabbendam & Van Os, 2005). The EST is an easy means of measuring this on the implicit level (Williams et al., 1996). An exciting avenue for further research would be in the predictive value of EST performance, which could help schedule appropriate interventions. This could be of special benefit in the high-risk-population, in which early intervention can help circumvent a possibly lifelong condition.

Study 2 had few potential limitations, which future research should aim to avoid. Replication studies should use more demanding measures of symptomatology. Subgroup assignment derived from the combined criteria of ICD-10 (World Health Organization, 1992) and the CAPE (Stefanis et al., 2002), which analysis suggested to be meaningful. Still, the PANNS (Kay et al., 1987) is a more widely used measure of symptomatology, and future research should take advantage of it if possible. Additionally, Study 2 failed to control some potentially important variables. For example, findings suggested that changes in the implicit processing of symptom-related emotion could relate to the respondent’s experience with these symptoms in both the present and the past. To interpret the effect that the time-course of symptomatology may have, future studies will need to monitor participant psychiatric history or the number of previous hospitalizations which they underwent.

6. Chapter 6: Conclusion

The emotion-paradox in schizophrenia describes a dissociation between explicit and implicit emotion processing. Two studies raised support for this conclusion, owing to their use of original material and method. In Study 1, participants with and without schizophrenia experienced the same musical emotion which they accurately perceived. In Study 2, participants with schizophrenia demonstrated preserved, and at times heightened implicit emotion. The results suggest that the notorious impairment of schizophrenic emotion perception does not generalize to implicit emotion and that the perception and experience of implicit emotion do not dissociate. Therefore, this thesis contradicts the staple interpretation of the emotion-paradox in schizophrenia (Edwards et al., 2002; Schneider et al., 2006; Shayegan & Stahl, 2005) and concurs with its critics (Darke et al., 2013; Mano & Brown, 2012; Rossell & Boundy, 2005; Roux et al., 2010; van ’t Wout et al., 2007). In particular, the second alternative interpretation of the emotion-paradox in schizophrenia (Mano & Brown, 2012; Roux et al., 2010; van ’t Wout et al., 2007) suits further use and study.

Several methodologic decisions strengthened the conclusion and protected its validity. Study 1 marked the first time that the perception and experience of an emotion relayed by the same stimulus faced actual, empirical investigation. Study 2 included the development of an emotional Stroop task, which helped provide a particularly comprehensive picture of implicit emotion reactivity in schizophrenia in its various states.

The studies included few limitations which future research should aim to address. Some modification of the overall study design may be recommended, to avoid participant fatigue and misunderstanding, as well as to facilitate additional measures. Indeed, if further study is to successfully identify the point of the break - at which emotion turns explicit and withers in schizophrenia – it will also require an innovative study design, which accommodates multiple measures of emotion processing, yet does not overwhelm its participants.

The findings and implications of this thesis can go beyond the mostly technical matter of the emotion-paradox in schizophrenia. Study 1 indicated that, in schizophrenia, musical emotions maintain some potentially beneficial characteristics: accurate perception and high intensity. Assuming that these characteristics can transfer onto other emotional processes, they could help combat a variety of negative symptoms, such as flat affect and anhedonia. This rationale appears to be the basis for music therapy (Silverman, 2003) but may require further empirical support.

However, the heightened intensity of musical emotions in schizophrenia could be less desirable in some phases of the disorder. Schizophrenia relates to a reduced capacity to regulate emotion, which can drop further during psychosis (Aleman & Kahn, 2005; Cohen & Minor, 2008). Furthermore, intense musical emotions may exacerbate dopaminergic hyperactivity (Chanda & Levitin, 2013), which itself underlies positive symptomatology (Davis et al., 1991; Howes & Kapur, 2009). For clients with psychosis, music therapy may require modification and careful management, as well as the backing of additional research. Relatedly, maladaptive uses of music could pose further issues in this stage of the disease and should be addressed in therapy (Farhall et al., 2007).

Fortunately, symptom-related music produced no stress reaction in persons with schizophrenia. In fact, these newly composed stimuli related to a seemingly improved ability of some subgroups to perceive and experience the emotion which the stimuli relayed. This finding suggests that musical symptom-relatedness alters the perception of the music in schizophrenia. Unfortunately, the finding also highlights a fundamental limitation of Study 1, i.e. its failure to assess the degree and kind of auditory deficits present in the sample. The relationship between the high rate of schizophrenia-related amusia (Hatada et al., 2014) on the one hand and the apparent maintenance of musical emotion in this population on the other deserves far greater empirical interest than it has received to-date.

Study 2, which derived from an emotional Stroop task, delivered concise evidence of some of the specific conditions in which implicit emotion processing is preserved, and in which it heightens in schizophrenia. The findings suggested that the implicit processing of negative content was unaffected by schizophrenia and only heightened in response to symptom-related emotion. Study 2 provided the first comprehensive account of this relationship between patient symptomatology and symptom-related emotion reactivity, finding distinct patterns of changes in persons with both positive and negative symptomatology, as well as in individuals with an acute psychotic disorder.

Increased reactivity to symptom-related emotion may promote the emergence and maintenance of schizophrenia (Krabbendam & Van Os, 2005), as has long been known for other psychiatric disorders (Williams et al., 1996). The emotional Stroop task, as developed for Study 2, represents an easy and efficient means of measuring the effect. As such, the task should see its application in clinical and prognostic studies. A longitudinal study of the high-risk population may be of particular benefit.

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Appendix A: Demographic Questionnaire and the Czech Version of the CAPE

CAPE

Instrukce k vyplnění:
Sebeposuzovací dotazník CAPE je určený k přeměření některých typů pocitů, myšlenek a prožitků, které se mohou vyskytovat v běžné populaci.

Dotazník je rozdělen do dvou sloupků. V **sloupku A** prosím rozhodněte, jak často míváte tázaný prožitek. Pokud si svou odpovědí nejste jisti, zatrhněte tu možnost, která Vaší zkušenosti odpovídá nejlépe. Pamatujte, že **není žádná špatná ani správná odpověď**.

Příklad sloupku A	Nikdy	Občas	Často	Téměř vždy
Míváte pocit, jako byste byli zcela sami?	0	1	2	3

Pokud odpovíte "**Občas (1)**", "**Často (2)**", nebo "**Téměř vždy (3)**", přejděte prosím ke **sloupku B**. Zde rozhodněte, do jaké míry Vás tázaný prožitek psychicky zatěžuje. Poté pokračujte k další otázce.

Pokud odpovíte "**Nikdy (0)**", přejděte rovnou k další otázce při **sloupku A**.

Příklad sloupku B	Vůbec ne	Jen trochu	Docela dost	Velmi
Do jaké míry Vás tento prožitek psychicky zatěžuje?	0	1	2	3

Vaše anonymita je zaručena tím, že je každému účastníku přiřazen číselný kód ID.

Uveďte prosím následující:
Věk: ……………………………………… Pohlaví: Žena / Muž / Jiné

Nejvyšší dosažené vzdělání: Celkový počet let školní docházky: …………
a) Základní
b) Střední bez výučního listu nebo bez maturity
c) Střední s výučním listem nebo s maturitou
d) Vysokoškolské

Nejvyšší dosažené hudební vzdělání:
a) Základní (např. povinná hudební výchova)
b) Střední nebo soukromé (např. volitelná hudební výchova / zpěv nebo hra na hudební nástroj)
c) Vysokoškolské (např. studium hudebního oboru nebo konzervatoře)

(vyplní výzkumný pracovník)

Datum vyplnění: ………………………… Číselný kód ID: …………………………………..

*** The following questions were administered to controls only. ***

Bylo Vám odborně diagnostikováno některé psychiatrické onemocnění?
(zaškrtněte vše hodící se)
a) Ne, nikdy mi nebylo diagnostikováno žádné psychiatrické onemocnění.
b) Organická porucha (onemocnění a úrazy mozku, demence)
c) Drogová závislost (závislost na alkoholu, lécích či psychoaktivních látkách)
d) Porucha nálad (deprese, bipolární afektivní porucha I nebo II)
e) Neurotická porucha
(úzkostná porucha, fobie, OCD, PTSD, konverze a somatoformní poruchy)
f) Vývojová porucha (autismus, Aspergerův syndrom)
g) Schizofrenie
h) Schizoafektivní porucha
i) Jiné onemocnění schizofrenního okruhu
(porucha s bludy, schizotypální porucha, akutní psychotická porucha)
j) Psychotická porucha neschizofrenního typu (toxická psychóza, psychotické stavy spojené s jiným onemocněním)
k) Nevím / Jiné:
…………………………………………………………………………………………..……

Uveďte prosím psychiatrické léky, které v současné době užíváte:
…………………………………………………………………………………………….…

Vyskytuje se schizofrenie, schizoafektivní porucha či jiné onemocnění schizofrenního okruhu u Vašich prarodičů, rodičů nebo sourozenců?
Ano / Ne / Nevím

THE EMOTION-PARADOX

Pokud odpovíte “Občas”, “Často”, nebo “Téměř vždy”, přejděte ke sloupku B. Pokud odpovíte “Nikdy”, přejděte k další otázce při sloupku A.

Sloupek A	Sloupek B
Jak často míváte tázaný prožitek?	**Do jaké míry Vás tento prožitek psychicky zatěžuje?**

#ID:	**Sloupek A**				**Sloupek B**			
	Nikdy	Občas	Často	Téměř vždy	Vůbec ne	Jen trochu	Docela dost	Velmi
1) Býváte smutní?	0	1	2	3	0	1	2	3
2) Míváte pocit, jako by o Vás lidé cosi naznačovali či mluvili v dvojích významech?	0	1	2	3	0	1	2	3
3) Míváte pocit, že nejste moc temperamentní?	0	1	2	3	0	1	2	3
4) Míváte pocit, že toho moc nenamluvíte, když s druhými hovoříte?	0	1	2	3	0	1	2	3
5) Míváte pocit, jako by části časopisů a televizních pořadů byly určeny přímo Vám?	0	1	2	3	0	1	2	3
6) Míváte pocit, jako by ostatní nebyli těmi, kterými se zdají být?	0	1	2	3	0	1	2	3
7) Míváte pocit, jako byste byli nějakým způsobem trestáni?	0	1	2	3	0	1	2	3
8) Míváte pocit, že Vás důležité události nechávají moc chladnými?	0	1	2	3	0	1	2	3
9) Býváte ke všemu pesimističtí?	0	1	2	3	0	1	2	3

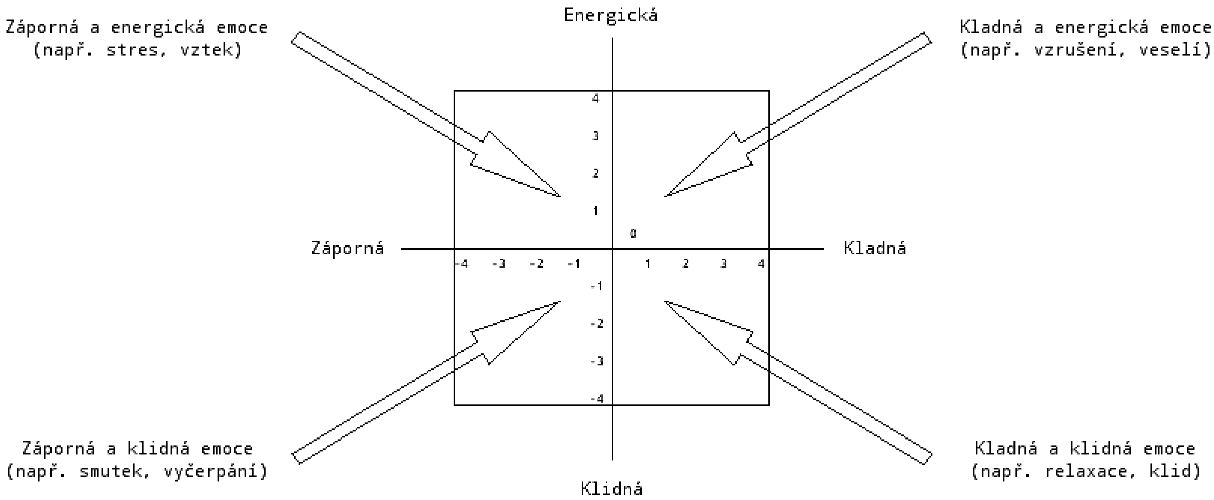
#ID:	Sloupek A				Sloupek B			
	Nikdy	Občas	Často	Téměř vždy	Vůbec ne	Jen trochu	Docela dost	Velmi
10) Míváte pocit, jako by proti Vám bylo nějaké spiknutí?	0	1	2	3	0	1	2	3
11) Míváte pocit, jako byste byli předurčeni být někým velmi významným?	0	1	2	3	0	1	2	3
12) Míváte pocit, jako by Vás v budoucnosti nic nečekalo?	0	1	2	3	0	1	2	3
13) Míváte pocit, že jste osoba výjimečná či neobyčejná?	0	1	2	3	0	1	2	3
14) Míváte pocit, jako byste už nechtěli dál žít?	0	1	2	3	0	1	2	3
15) Zdává se Vám, že ostatní dokáží komunikovat telepaticky?	0	1	2	3	0	1	2	3
16) Míváte pocit, že nemáte zájem trávit čas ve společnosti druhých?	0	1	2	3	0	1	2	3
17) Míváte pocit, jako by elektronická zařízení, například počítače, ovlivňovala Vaši mysl?	0	1	2	3	0	1	2	3
18) Býváte bez chuti k jakékoli činnosti?	0	1	2	3	0	1	2	3
19) Stává se Vám, že se bezdůvodně rozpláčete?	0	1	2	3	0	1	2	3

#ID:	Sloupek A				Sloupek B			
	Nikdy	Občas	Často	Téměř vždy	Vůbec ne	Jen trochu	Docela dost	Velmi
20) Věříte v čarodějnictví, voodoo či okultismus?	0	1	2	3	0	1	2	3
21) Míváte pocity nedostatku energie?	0	1	2	3	0	1	2	3
22) Míváte pocit, že na Vás kvůli Vašemu vzezření ostatní divně koukají?	0	1	2	3	0	1	2	3
23) Míváte pocit, že je Vaše mysl prázdná?	0	1	2	3	0	1	2	3
24) Míváte pocit, jako by Vám někdo/ něco bralo myšlenky přímo z hlavy?	0	1	2	3	0	1	2	3
25) Míváte pocit, že trávíte celé dny nicneděláním?	0	1	2	3	0	1	2	3
26) Míváte pocit, jako by Vám vlastní myšlenky nepatřily?	0	1	2	3	0	1	2	3
27) Zdává se Vám, že jsou Vaše pocity nedostatečně silné?	0	1	2	3	0	1	2	3
28) Bývají Vaše myšlenky tak živé, že se obáváte, zda je ostatní také neslyší?	0	1	2	3	0	1	2	3
29) Míváte pocit, že nejste dost spontánní?	0	1	2	3	0	1	2	3
30) Slýcháváte, jak se k Vám myšlenky vrací ozvěnou?	0	1	2	3	0	1	2	3

#ID:	Sloupek A				Sloupek B			
	Nikdy	Občas	Často	Téměř vždy	Vůbec ne	Jen trochu	Docela dost	Velmi
31) Míváte pocit, jako by Vás ovládaly cizí síly?	0	1	2	3	0	1	2	3
32) Míváte pocit, že jsou vaše emoce otupené?	0	1	2	3	0	1	2	3
33) Slýcháváte hlasy, když jste sami?	0	1	2	3	0	1	2	3
34) Slýcháváte cizí rozhovory, když jste sami?	0	1	2	3	0	1	2	3
35) Míváte pocit, že zanedbáváte svůj zevnějšek či hygienu?	0	1	2	3	0	1	2	3
36) Míváte pocit, že nic nezvládáte dokončit?	0	1	2	3	0	1	2	3
37) Míváte pocit, že máte málo zájmů či koníčků?	0	1	2	3	0	1	2	3
38) Míváte pocity viny?	0	1	2	3	0	1	2	3
39) Míváte pocity selhání?	0	1	2	3	0	1	2	3
40) Býváte napjatý?	0	1	2	3	0	1	2	3
41) Míváte pocit, jako by Vašeho přítele, známého či člena rodiny nahradil dvojník?	0	1	2	3	0	1	2	3
42) Vídáváte předměty, osoby nebo zvířata, co ostatní nevidí?	0	1	2	3	0	1	2	3

Appendix B: Instructions Sheet for Study 1

POMŮCKA K HODNOCENÍ HUDEBNÍCH UKÁZEK



1) PRAVÝM klikem myši do prostoru mřížky hodnotíte VJEM (ikona ucha), tedy jak kladná/záporná a energická/klidná se ukázka sama snaží být. Chcete být OBJEKTIVNÍ.

2) LEVÝM klikem myši do prostoru mřížky hodnotíte PROŽITEK (ikona srdce), tedy jak kladně/záporně a energicky/klidně se při poslechu sami cítíte. Chcete být SUBJEKTIVNÍ.

VŽDY POKRAČUJTE STISKNUTÍM MEZERNÍKU

Appendix C: List of EST Stimuli

Control			**PS-related**			**NS-related**		
	Czech	*English*		*Czech*	*English*		*Czech*	*English*
Neu	sborovna	staffroom	Neu	nesmysl	nonsense	Neu	chlad	cold
	leták	leaflet		trouba	dodo		tíha	weight
	pochůzka	errand		kout	corner		útlum	slowdown
	částečný	partial		lačný	eager		plyne	pass
	lampa	lamp		poslechni	listen		stranit	retreat
	závěs	curtain		šepot	whisper		němý	mute
	jmenný	name		hlasy	voices		nijaký	bland
	osada	settlement		ovladač	control		tikat	tick
	uzel	knot		sledovat	watch		nešika	clumsy
	obsah	content		zbožný	pious		návyk	habit
	prostý	plain		léčit	cure		fáze	phase
	okno	window		tabák	tobacco		ledovec	iceberg
	nástroj	tool		záhada	mystery		ticho	silence
	dálnice	highway		špión	spy		stroj	machine
	statek	farm		salát	salad		poušť	desert
	věž	tower		myšlenka	thought		polohy	postures
	židle	chair		svatý	saint		utěšit	comfort
	pozdraví	greets		pocta	honour		vrátí	return
	veslo	paddle		idol	idol		soukromí	privacy
	motorový	motor		sen	dream		pozornost	attention

Control			**PS-related**			**NS-related**		
	Czech	*English*		*Czech*	*English*		*Czech*	*English*
Neg	pohřeb	funeral	Neg	tyran	tyrant	Neg	srab	coward
	válka	war		otrok	slave		bezmoc	helplessness
	sobec	selfish		jed	poison		krach	failure
	vrah	murderer		zapáchá	stink		úzkost	anxiety
	úraz	injury		strach	fear		zbabělec	sissy
	neštovice	smallpox		trauma	trauma		zanedbat	neglect
	ničit	destroy		oplzlý	obscene		zklamal	disappoint
	vandal	vandal		červi	larvae		ztráta	loss
	otrava	bother		hnít	rot		odmítnut	refused
	mrtvý	dead		svinstvo	filth		zbytečný	worthless
	surový	brute		oběť	victim		smutek	sadness
	srážka	crash		urážka	offense		nouze	dearth
	škváry	pulp		trestán	persecuted		neschopa	incompetent
	zběh	renegade		hrozba	threat		stud	shame
	horečka	fever		stíha	paranoia		chudý	poor
	ponurý	gloomy		vetřelec	alien		poražen	defeated
	lupiči	thieves		muka	torment		nuda	boredom
	bolet	pain		porucha	disorder		osamění	solitude
	nadváha	overweight		bludy	delusions		brečí	weeps
	nevěra	cheat		podezřelí	suspicious		lenoch	deadbeat

Appendix D: Mean Ratings of Perceived and Experienced Valence and Arousal

Table D 1. Mean ratings of perceived and experienced valence.

Excerpt			Perceived valence		Experienced valence	
			Control	SZ	Control	SZ
ID	Valence	Type	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
J			-2.43 (1.35)	-1.31 (2.24)	-2.25 (1.56)	-1.20 (2.32)
O			-.53 (1.92)	-.59 (2.41)	-0.79 (2.02)	-0.60 (2.21)
L			-1.09 (1.96)	-1.14 (2.00)	-0.90 (1.92)	-1.32 (1.73)
	Negative		-1.35 (1.27)	-1.02 (1.69)	-1.31 (1.49)	-1.01 (1.52)
N			-.87 (1.81)	-.45 (2.12)	-0.65 (1.86)	-0.25 (2.04)
P			.85 (1.78)	1.45 (1.61)	0.41 (1.82)	1.21 (1.75)
R			.11 (1.74)	.46 (1.70)	0.11 (1.71)	0.18 (1.88)
	Moderate		.03 (1.31)	.50 (1.04)	-.07 (1.34)	.39 (1.22)
K			1.57 (1.49)	1.80 (1.36)	1.63 (1.50)	1.52 (1.71)
Q			1.81 (1.25)	1.57 (1.92)	1.76 (1.41)	0.85 (2.13)
M			1.67 (1.42)	1.92 (1.16)	1.71 (1.40)	1.52 (1.89)
	High		1.68 (1.08)	1.76 (1.07)	1.70 (1.13)	1.30 (1.49)
		Standardized	.12 (.88)	.41 (.80)	.11 (1.06)	.23 (1.05)
A			-1.38 (1.57)	-1.90 (1.92)	-1.75 (1.60)	-1.74 (2.01)
F			-.89 (1.77)	-.09 (2.06)	-1.04 (1.77)	-0.39 (2.24)
C			-.33 (1.67)	-.74 (2.17)	-0.81 (1.68)	-0.98 (2.12)
	Negative		-.87 (1.09)	-.92 (1.48)	-1.20 (1.20)	-1.04 (1.38)
E			1.41 (1.45)	.70 (1.73)	1.03 (1.44)	0.65 (2.00)
G			.47 (1.62)	.15 (1.90)	0.42 (1.80)	-0.12 (2.05)
I			.29 (1.53)	.06 (1.90)	0.35 (1.69)	-0.39 (1.92)
	Moderate		.72 (1.02)	.31 (1.05)	.60 (1.00)	.11 (1.38)
B			.50 (1.52)	1.35 (1.59)	0.50 (1.72)	1.30 (1.99)
H			.90 (1.52)	1.18 (1.74)	0.89 (1.69)	0.93 (2.15)
D			1.41 (1.47)	1.46 (1.80)	1.01 (1.69)	1.01 (2.07)
	High		.94 (1.01)	1.36 (1.23)	.80 (1.21)	1.09 (1.59)
		Newly composed	.26 (.65)	.22 (.92)	.07 (.76)	.04 (109)
		Grand total	.19 (.66)	.32 (.68)	.07 (.74)	.14 (.94)

Table D 2. Mean ratings of perceived and experienced arousal.

Excerpt			Perceived arousal		Experienced arousal	
ID	Arousal	Type	Control *M* (*SD*)	SZ *M* (*SD*)	Control *M* (*SD*)	SZ *M* (*SD*)
J			-0.85 (2.10)	-1.52 (1.91)	-1.22 (2.00)	-0.80 (1.80)
N			-1.35 (1.78)	-1.70 (1.57)	-1.64 (1.60)	-1.93 (1.42)
K			-1.03 (1.94)	-1.55 (1.78)	-0.92 (1.76)	-1.54 (1.69)
	Negative		-1.08 (1.46)	-1.59 (1.32)	-1.26 (1.10)	-1.43 (1.00)
O			-0.78 (1.81)	-0.99 (1.80)	-1.05 (1.29)	-0.97 (1.87)
P			-0.89 (1.85)	-0.80 (1.90)	-0.77 (1.75)	-0.85 (1.85)
Q			-1.44 (1.74)	-1.30 (1.72)	-1.21 (1.94)	-1.28 (1.84)
	Moderate		-1.04 (1.21)	-1.03 (1.28)	-1.01 (1.15)	-1.02 (1.18)
L			2.29 (1.14)	2.09 (1.74)	2.13 (1.13)	1.59 (1.90)
R			2.30 (0.78)	2.43 (1.32)	1.70 (1.25)	2.00 (1.43)
M			2.21 (1.35)	1.52 (1.92)	1.79 (1.39)	1.27 (1.80)
	High		2.27 (.91)	2.05 (1.09)	1.87 (.90)	1.62 (1.24)
		Standardized	.06 (.83)	-.21 (.87)	-.13 (.75)	-.30 (.81)
A			1.02 (1.60)	-0.48 (2.12)	0.69 (1.41)	-0.28 (1.87)
E			-0.35 (1.67)	-1.05 (2.14)	-0.05 (1.58)	-0.95 (1.91)
B			-0.57 (1.54)	-1.49 (1.83)	-0.76 (1.76)	-1.04 (1.78)
	Negative		.03 (1.06)	-1.00 (1.17)	-.04 (1.00)	-.75 (1.23)
F			0.01 (1.45)	-1.37 (1.72)	-0.34 (1.39)	-1.03 (1.74)
G			0.44 (1.74)	-0.09 (2.30)	0.24 (1.52)	-0.33 (2.18)
H			0.27 (1.85)	-0.82 (2.07)	0.23 (1.72)	-0.51 (2.00)
	Moderate		.24 (1.22)	-.77 (1.43)	.04 (1.08)	-.62 (1.49)
C			2.37 (1.22)	2.69 (1.03)	1.54 (1.70)	2.38 (1.54)
I			1.66 (1.34)	2.11 (1.66)	1.52 (1.13)	1.77 (1.81)
D			2.15 (0.91)	1.89 (1.82)	1.78 (1.29)	1.02 (2.19)
	High		2.06 (.90)	2.21 (.97)	1.61 (1.06)	1.80 (1.48)
		Newly composed	.78 (.77)	.16 (.86)	.54 (.73)	.14 (1.07)
		Grand total	.41 (.61)	-.04 (.75)	.20 (.57)	-.09 (.79)